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LOGISTICS PERFORMANCE MEASURES FOR DIRECT AND GENERAL SUPPORT UNITS

Leon N. Karadbil, et al

Research Analysis Corporation

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Logistics Performance Measures for Direct and General Support Units

by Leon N. Karadbil
Sean P. Foohey
Douglas E. Smith
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13 ABSTRACT

An analysis of supply (Class IX) and maintenance performance measures and objectives at direct support (DS) and general support (GS) units is reported on herein. Visits were made to several CONUS and USAREUR units and data on operations were obtained. These data were used in simulation models and other analytic devices to assure internal consistency of various measures and to assess their relative contributions to overall unit performance. DS/GS operations were evaluated in terms of mission—the support of troop units. Accordingly, measures and objectives ranked by relative importance are recommended for the supply and maintenance functions. The effects of higher echelon policy on the supply effectiveness of the support unit were explored and quantified. Some thirty measures are discussed; data, sources and analytic rationale are presented.

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FOREWORD

This document reports on the first phase of a DCSLOG-sponsored inquiry into the establishment of logistic performance measures and goals. The focus of the study effort was on the direct and general support unit level with emphasis on the supply and maintenance functions. Models developed in the course of previous work for the Army were used to evaluate the effects of alternative supply policies on performance levels.

Lee S. Stoneback
Director, Logistics Department

RAC

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At RAC, Mrs. Jane Meyer, Mrs. Alison Crews, Mr. Harry Sheets and Mrs. Marion Hammerman provided material assistance in the computer processing of data and the running of models. This document was reviewed and thereby improved by MG S. D. Smith, Jr (USA-Ret), Dr. R. G. Ruppenthal, Mr. C. J. Christianson, Dr. C. P. Fuelling and Mr. M. T. Henry. The authors were privileged to draw upon the experience and insight of GEN Frank S. Besson, Jr (USA-Ret), consultant at RAC, who provided constructive comment throughout the study. Finally, the daily statistical and typing tasks were accomplished by Mrs. Thelma Chesley and Mrs. Loretta Kelly.

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SUMMARY

A profusion of performance guidance and measures is spread throughout a variety of official Army documents. In addition, local commands adopt and adapt measures reflecting their individual management concepts. Neither the internal consistency of these measures nor their relative importance have been subjected to critical analysis. The Deputy Chief of Staff for Logistics (DCSLOG) sponsored this analysis of logistics performance measures/goals for direct support and general support (DS/GS) units, directing that phase 1 of the study focus on the DS/GS level.

After reviewing previous work and policy in the performance area, troop units were visited in Continental US (CONUS) and US Army, Europe (USAREUR). The data and information obtained there were analyzed, largely via the use of models to determine the effects of policy on performance and the impact of one measure on others. Where relations could be quantified with statistical confidence, this was done. Where measures seemed useful yet data were incomplete, approaches or values were suggested.

The dominant objective of this study was to determine which measures of performance, whether currently in use or not, reflected support unit effectiveness. Objectivity was sought in two ways: through an on-site understanding of unit operations and via the use of quantitative indicators of these operations. The measures listed in Table 1, ranked according to relative importance, are those that the study group concluded were the most significant among the many analyzed. It was also concluded that support unit performance is importantly affected by policies imposed by higher echelons.

Evaluation of the direct support unit (DSU) operation must be in terms of its mission, i.e., the support of troop units. From the

customer units' standpoint that support is provided in repair parts and repair of equipment as required. In negative terms, when equipment is deadlined, support is lacking to that extent, so that not operationally ready, supply (NORS) is a primary system measure of supply effectiveness and not operationally ready, maintenance (NORM) of maintenance effectiveness. Ancillary and subsidiary functions contribute to these primary measures. Not only is there a complex interrelation among functions and their measurement but also there is a vertical impact on the DSU deriving from the total system operation and efficiency.

Supply performance derives both from the governing rules or policies and the efficiency of the unit involved. Stockage policy — what, when, and how much to stock — in particular is a significant determinant of DSU performance. Stockage measures and objectives were examined, largely through the use of simulation models. The interdependence of significant measures was quantified using correlation analysis. The primary measures affected by stockage breadth policy for which objectives are proposed are: authorized stockage list (ASL) size, ASL demand accommodation, ASL turbulence, NORS, zero balances with dues-out and tech supply fill rate. The latter two measures are also influenced by stockage depth policy as is the average duration of a parts shortage. Alternative quick supply (QS) policies were evaluated and measures comprising list size, fill rate and zero balances were recommended.

In the maintenance area an attempt was made to correlate customer units' NORM rates with turnaround time (TAT) at the DSU. TAT, the main measure of a DSU's effectiveness, was related to supply. The wait for parts accounts for a considerable segment of long repair-and-return-to-user times. Although about half the maintenance job orders are completed within 10 days, the remainder can require hundreds of days.

The principal performance measures considered are summarized in Table 1. For each, a level of importance is assigned that derives from analysis of empirical data, model output and the logic of the systems under review. Where possible, multiple regression analysis was used to quantify the relative importance of the measures.

Replace Table 1, pp 3 and 4 with this corrected table.

Table 1

SUMMARY OF PRINCIPAL DSU PERFORMANCE MEASURES

Measure	Level of importance	Objective	Influenced by: Policy	Influenced by: Local commander	Influenced by: Entire system	Reference in text page no.
Supply						
NORS	1	<5%	X	X	X	33,38,72
ASL mobility index	1	50%	X	X	X	117
Tech supply fill rate	2	64%	X	X	X	38,58,62,78
Tech supply quantity fill rate	2	60-64%	X	X	X	62
Deadliner stockage index (DSI)	2	---[a]	X	X	X	43,125
Supply system response rate (SSRR)	2	56%	X	X	X	133
DX quantity fill rate	2	75%	X	X	X	132
DX deadline index	2	<5%		X	X	133
QS fill rate	2	70%	X	X	X	106
QS zero balance with unfulfilled requirements	3	<3%	X	X	X	108
QS list size, lines	3	1700	X			111
ASL fill rate	3	71%	X	X	X	64,67
Zero balance with dues-out	3	<5%	X	X	X	62,68,87
ASL demand accommodation	3	82%	X	X	X	54,62
ASL size	3	variable	X			54
ASL turbulence	3	~1%	X	X	X	60,63
ASL dues-in over 180 days	3	<5%			X	137
Avg inventory value	3	---[a]	X	X		72,81
SOH/RO	3	<75%	X	X	X	142
Annual shortage quantity, parts	3	<200,000	X		X	84
Avg shortage duration	3	<52 days	X	X	X	84
DSU request processing time:	3					
• automated		<3 days		X		146
• manual		<4 days		X		146
DSU receipt processing time	3	<5 days		X		148
NSL fill rate	3	---[a]		X		64
NSL dues-in over 180 days	3	<3%			X	139
Acquisition value of excesses	3	<$140,000		X		145
Unidentifiable excesses:	3					
• lines		<10		X		145
• items		<100		X		145
Maintenance						
NORM	1	<2%		X	X	33,156
Turnaround time (TAT)	2	<10 days		X	X	156,187
Manpower utilization index	3	25-50%		X	X	175

Table 1 (continued)

Measure	Level of importance	Objective	Influenced by: Policy	Influenced by: Local commander	Influenced by: Entire system	Reference in text page no.
Ratio of man-hours to time in shop	3	---[b]		X	X	196
Workload and backlog indicators	3	---[b]		X		197

[a]A more complete historical record is required before an objective can be rationalized.

[b]Intended as management indicators for DSU/GSU commanders; objectives to be established locally.

Note: NORS is not operationally ready, supply
ASL is authorized stockage list
DX is direct exchange
QS is quick supply
SOH is stock on hand
RO is requisitioning objective
NSL is nonstockage list
NORM is not operationally ready, maintenance

Likewise, objectives are given for the measures, and the effects of policy, local command emphasis, and the entire system's performance are noted.

A full discussion of each measure begins on the page cited in the last column of Table 1. A very brief definition of each, with an indication of the rationale for its objective, immediately follows the table.

DEFINITIONS OF THE DSU PERFORMANCE MEASURES

Supply Measures

NORS. Not operationally ready, supply (NORS) refers to that status of equipment wherein its mission cannot be performed because the parts required to repair it are not available. It is usually computed on a quarterly basis, by equipment type. From the number of equipments of a type on hand, and the number of days in the quarter, NORS is the quotient of equipment-days nonavailable due to lack of parts divided by total possible equipment-days. The objective of 5 percent has been selected because empirical data indicate that it is attainable, and the results of computer simulations confirm its consonance with other important measures discussed herein.

ASL Mobility Index. The ASL mobility index measures a DSU's capability to move its ASL in a single displacement with its own transportation. The index is computed by dividing the number of lines transportable by the total ASL lines, and expressing the answer as a percentage. The objective of 50 percent is based upon a comparison of the weight and cube capacities of the DSU's organic transportation with the weight and cube requirements imposed by average ASLs. The latter have been tallied from empirical data, and have also been estimated using simulation outputs. Both sources indicate that an objective of 50 percent represents an optimistic estimate of what is achievable, given current constraints.

Tech Supply Fill Rate. Tech supply fill rate is the percent of total valid demands received, for stocked and for nonstocked lines, that experience immediate fill. As there is a direct relationship between tech supply fill rate and NORS, the objective of 64 percent stated in Table 1 is derived directly from outputs of computer simulations in which the NORS is set at 5 percent.

Tech Supply Quantity Fill Rate. Tech supply quantity fill rate is the percent of total valid quantity demanded, for stocked and nonstocked lines, that experiences immediate fill. In this case, the numerator includes those quantities that constitute partial fills. The objective of 60 to 64 percent represents the range of results achievable based on simulations of two different divisions operating under current Army supply policies.

Deadliner Stockage Index (DSI). The DSI is the fraction of lines that is causing equipment to be deadlined for parts that appear on the ASL. This index cannot be readily measured currently, so no objective has been suggested for it. However, its importance should be clear: because equipments deadlined for lack of required parts are the sole contributors to NORS, stockage of these parts would be most desirable.

Supply System Response Rate (SSRR). The SSRR is the sum of fills provided immediately, backorder releases, and dues-in receipts expressed as a percentage of cumulative commitments. Commitments include demands received during the period of report, plus the sum of open backorders and dues-in at the beginning of the period. The objective of 56 percent is based upon an analysis of 8 months' worth of data from an armored division.

DX Quantity Fill Rate. The DX quantity fill rate is that percentage of total quantity demanded for direct exchange (DX) lines that is supplied on request. The objective of 75 percent is based on an analysis of detailed DX records from a nondivisional maintenance battalion in Germany. Though not directly obtainable from model output, the objective correlates well with similar output for tech supply operations.

DX Deadline Index. The DX deadline index is the percentage of total equipments deadlined for a part(s) that appears on the DX list of the supporting DSU. It is a measure of the degree to which the NORS rate is influenced by the quality of DX support. Its objective is based upon the experience of one nondivisional DSU, in which 5 percent was found to be feasible.

QS Fill Rate. Quick supply (QS) fill rate is directly analogous to tech supply fill rate. It is the percentage of demands received at a DSU for lines appearing on the QS list for which immediate fill is obtained.

A significant portion of the supply support provided by DSUs is currently handled through these simplified procedures, or through the similar "country store" concept in Europe. The objective selected, 70 percent QS fill rate, has been demonstrated via simulation to be attainable within both the QS and the country store concepts.

QS Zero Balance with Unfulfilled Requirements. This measure indicates the percent of lines on the DSU's QS list for which there are no assets on hand, and for which one or more of that DSU's customers has expressed a current unsatisfied need. The suggested objective of less than 3 percent is based upon simulation of the country store-type policy, in which this measure ranged from 2.9 to 3.3 percent.

QS List Size. QS list size is the number of lines stocked under the QS concept at a DSU. The QS concept is at once desirable because of simplified request and issue procedures, and undesirable because detailed demand history is not maintained, thus making stockage quantity decisions more difficult. Thus it is desirable to keep the list size to a minimum consistent with good performance and overall ease of operation. The size suggested as an objective, 1700 lines, is based upon simulations testing several variations of the basic QS concept. It was found that this objective could be attained while achieving relatively high fill rates and relatively low zero balances with unfulfilled requirements. In addition, it is consistent with objectives already selected for other measures of QS performance.

ASL Fill Rate. ASL fill rate, also known as demand satisfaction, is defined as the percent of valid demands for ASL lines that is filled immediately. The suggested objective of 71 percent is derived analytically from other simulation outputs, and is congruous with the tech supply fill rate objective discussed above.

Zero Balance with Dues-out. This measure indicates the percent of ASL lines for which there are no assets currently available, and for which one or more dues-out to customers are on record. Its interpretation is similar to that of QS zero balances with unfulfilled requirements, and it is equivalent in importance. The objective of less than 5 percent was selected on the basis of multiple regression analysis of simulation outputs: the mean value for all simulations was 5.6 percent, with a standard deviation of only 0.9.

<u>ASL Demand Accommodation</u>. This measure, the percentage of total demands that match the ASL, is directly related to ASL size, and thus is important in terms of financial considerations. The objective of 82 percent has been derived from the simulation results that yielded 64 percent tech supply fill rate. Thus, these two measures are consistent.

<u>ASL Size</u>. ASL size is the number of different lines that appears on the authorized stockage list of the supply point. ASL size is directly determined by the stockage policy imposed, and is directly related to demand accommodation. These relationships have been determined through application of the RAC Stockage Criteria Model (SCM) to empirical data. The objective suggested is variable because local differences in demand pattern influence the ASL size required to achieve the suggested level of demand accommodation.

<u>ASL Turbulence</u>. ASL turbulence is defined as the amount of fluctuation in the ASL within a year, expressed as a percentage of list size. Using the SCM it was determined that the magnitude of turbulence is influenced by the stockage policy in force. The smaller the difference between stockage addition and retention criteria, the greater the turbulence. In addition, frequency of ASL review affects turbulence — the more frequent the review, the higher the level of turbulence. In the perfect bookkeeping and control environment of simulation runs, stockage list turbulence does not significantly affect the primary measures of supply performance. In the less ideal environment of a direct support unit, however, the instability of a stockage list creates workload and management difficulties. Accordingly an achievable objective of less than 1 percent turbulence has been suggested.

<u>ASL Dues-in Over 180 Days</u>. This measure indicates the percentage of total requisitions awaiting fill that have been pending for more than 180 days. Based upon an evaluation of the Direct Support System (DSS) in Europe, about 5 percent of ASL dues-in exceed 180 days. This is consistent with the simulation-predicted 4.7 percent of lines at zero balance with dues-out under current stockage policies.

<u>Avg Inventory Value</u>. The dollar value of average inventory on hand at the DSU is one way of relating cost to performance levels.

Using a simulation model it was determined that an average inventory value of $325,000 would result from imposition of current supply policy at the division simulated. However, no objective has been selected for this measure because local variations in stockage depth policy could result in different values. Nevertheless, the relationships among inventory investment, fill rates and NORS are important and should be measured regularly.

SOH/RO Ratio. This ratio of SOH to RO may be expressed using either the quantity or dollar value of current SOH for ASL items, and the quantity or dollar value of the RO. Its purpose is to indicate potential shortages or costly overages in assets on hand. Inventory theory suggests that the maximum stock on hand, operating level plus safety level assets, will always be less than the RO. Thus the maximum stock on hand to RO ratio would vary from 50 to 70 percent based upon empirical RO values from 25 maintenance companies in Europe. The objective of less than 75 percent has been selected based upon these empirical data.

Annual Shortage Quantity, Parts. Annual parts shortages have been found to be directly related to depth of stockage. Based upon simulation model results in which current Army stockage depth policy was applied to one division's demand history, the objective of less than 200,000 parts per year has been derived.

Average Shortage Duration. Shortage duration is a function not only of the stockage depth policy, but also of the frequency of reorder. Based upon the same simulation cited above, it was found that an average shortage duration of about 52 days is consistent with the other objectives selected for a DSU operating under current Army procedures.

DSU Request Processing Time. DSU request processing time is the number of days from the date a user request is received at the DSU to the date of the materiel release order, or to the date of assignment of the document number in the case of an out-of-stock position. The objective of less than 4 days for a manual system is based upon a 1965 RAC analysis of empirical data from the then-manual DSUs in Europe. These DSUs are now automated; if one assumes a minimum of two cycles per week, the objective of under 3 days for an automated system should be attainable.

DSU Receipt Processing Time. Receipt processing time is the elapsed time from receipt of requisitioned materiel until that receipt

is posted to DSU accountable records. Though current objectives for this measure are as low as 2 days, empirical data indicate averages above 7 days. The 5 day objective represents a reasonable compromise.

NSL Fill Rate. NSL fill rate is the percent of total demands for non stockage list items that experiences immediate fill. Outputs from RAC simulation models automatically combine NSL and ASL fill rates to derive the tech supply fill rate. However, available empirical data do not reveal the source of fill. Thus it is generally assumed that no fill is obtained from NSL assets. To the extent that this is not true, the tech supply fill rates would be understated. It has been determined analytically that the degree of understatement would be small, even if as much as 30 percent of NSL requests are filled. Thus no objective has been advanced for this measure.

NSL Dues-in Over 180 Days. Again using DSS data, a distribution of NSL dues-in ages was developed. From it the objective of 3 percent or less was derived.

Acquisition Value of Excesses. The acquisition value of excesses is the aggregate of individual quantities in excess multiplied by their item unit prices. The assumption is made that the value of excesses should not exceed the value of average SOH. The average SOH values were computed from RO values for 25 units in Europe. The objective of $140,000 is suggested for main support companies of DSUs.

Unidentifiable Excesses: Lines and Items. Field observation has revealed that many of the excesses found at a DSU are unidentifiable and thus are not reportable in terms of acquisition value. The objectives of 10 lines and 100 items are proposed as reasonable upper limits on unidentifiable assets on hand.

Maintenance Measures

NORM. Not operationally ready, maintenance (NORM) refers to the status of the equipment whose mission cannot be performed because it is undergoing maintenance. As with NORS, NORM is the quotient of equipment-days non available due to maintenance divided by total possible equipment-days. The objective of less than 2 percent is based upon quarterly data from the Logistics Data Center for 6 combat divisions. The overall average for a 2-year period was 1.8 percent.

Turnaround Time (TAT). TAT is the elapsed days between receipt of a job order at a maintenance shop and the date of its completion. Empirical data indicate that median TAT is less than 10 days for virtually all categories of equipment, and for both the direct and general support levels.

Manpower Utilization Index (MUI). MUI is the ratio of maintenance man-hours expended to available man-hours, and is expressed as a percent. Analyses of 26 maintenance units in Europe indicated ranges of MUI from 2 to 56 percent. Thus a range of 25-50 percent is suggested for this measure.

Ratio of Man-Hours to Time in Shop. This ratio of total number of maintenance man-hours recorded to the total TAT (in hours) is suggested as a management aid to the local support unit commander. RAC calculations of the measure indicate rather large variations due to types of jobs encountered, thus no objective has been set.

Workload and Backlog Indicators. Eight measures of workload and backlog are suggested as management tools. Each could be readily measured at the end of specified reporting periods; objectives for them could be determined locally for use in regulating work flow, manpower, facilities and materiel.

LOGISTICS PERFORMANCE MEASURES

FOR

DIRECT AND GENERAL SUPPORT UNITS

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ABBREVIATIONS

AMDF	Army Master Data File
ASL	authorized stockage list
BASOPS	Base Level Operating Information System
CC&S	collection, classification and salvage
CONUS	Continental US
COSCOM	corps support command
CS_3	Combat Service Support System
DA	Department of Army
DCSLOG	Deputy Chief of Staff for Logistics
DISCOM	division support command
DLOGS	Division Logistics System
DON	document order number
DPD	data processing detachment
DS	direct support
DSI	deadliner stockage index
DSS	Direct Support System
DSU	direct support unit
DX	direct exchange
EIP	economic inventory policy
EOQ	economic order quantity
FORTRAN	Formula Translator
FSN	Federal stock number
GS	general support
GSU	general support unit
HEM	heavy equipment maintenance (company)
IPD	issue priority designator
LDC	Logistics Data Center (Lexington, Ky)
LEM	light equipment maintenance (company)
LS	labor service (company)
MIR	master inventory record
MMA	Materiel Management Activity
MRO	materiel release order
MUI	manpower utilization index
MWO	modification work order

NICP	national inventory control point
NOR	not operationally ready
NORM	not operationally ready, maintenance
NORS	not operationally ready, supply
NSL	nonstockage list
OL	operating level
OR	operational readiness
OST	order shipping time
PLL	prescribed load list
QS	quick supply
RO	requisitioning objective
ROSA	Report of Supply Activity
RP	reorder point
SAG	Study Advisory Group
SALTI	summary accounting for low dollar turnover items
SCM	Stockage Criteria Model
SL	safety level
SOH	stock on hand
SPSM	Supply Point Simulation Model
S&S	supply and service
SSRR	supply system response rate
S&T	supply and transportation
TAMMS	The Army Maintenance Management System
TAT	turnaround time
TMCS	Tactical Maintenance Control System
TOE	table of organization and equipment
TRICAP	triple capability
USAREUR	US Army, Europe

Chapter 1

INTRODUCTION

BACKGROUND

Management of a large operation generally requires operational data, the establishment of goals, and the feedback to the manager of those data elements that permit him to measure the degree of accomplishment with respect to his goals. The growth of the science of management and the consequent information explosion is pervasive, not only in the private sector but also in the public sector. A few years ago three US Army divisions in Europe estimated (and these estimates are not atypical) the time spent in compiling and preparing over 90 recurring logistics reports at about 100,000 man-hours per division per year.[1] Since then computers have been installed in these divisions, most reporting is automated, and the number of data elements reported has undoubtedly increased. The potential for devising and getting performance and status reports has risen sharply as a function of automation and, it may be presumed, so has the actual reporting.

Given widespread automation and a multibillion dollar, multiechelon, multifaceted Army logistics operation with varied hardware and software systems in the several theaters, it is apparent that many different measures of performance are in use. At one installation the chief of a major directorate maintains a management book in which over 100 indicators (measures) are posted regularly. HQ USAREUR publishes a monthly Report of Supply Activities (ROSA), some 60 pages of tables and charts on DSU supply performance. At the combat division level, under the Division Logistics System (DLOGS) and Combat Service Support System (CS_3), the amount of automated

logistics operations data available to the commander-manager is substantial.

Difficulty arises, however, when an attempt is made to assess the relative importance of the several performance factors. Also little attempt has been observed to isolate cause, effect, and the relations between functions and measures. Typically the division commander uses equipment readiness as his indicator of logistics support. The DSU commander tends to manage by the exceptions exemplified by complaints from either his customers or superiors.

PROBLEM

The official work statement under which the study reported on herein was done phrased the problem as follows:

> Responsiveness of logistic support to force readiness has been a concern, and inability to measure the degree of responsiveness has to a great measure been due to the lack of or use of inappropriate performance measurement standards. The degree and coverage of performance evaluation systems are not uniform, and varied techniques are used at different levels of logistic management. In some cases, no standards are used. Therefore, there is a need to analyze the current system, the validity thereof and the acceptability of measures and standards now in use. Analysis is required of operations and performance measurement at each level of command and related to each functional operation for which effectiveness should be measured.[2]

APPROACH

The research approach was fourfold: (a) the literature was reviewed including previous related studies, current Army regulations, bulletins, and circulars; (b) field trips were made to a number of DSUs, GSUs, and higher echelons both in CONUS and USAREUR to acquire the information needed to understand and, if possible, measure the key segments of the logistics subsystems; (c) the data and knowledge acquired during these field trips were run through several RAC-developed models to develop and test relations between variables and to determine whether threshold values suitable for setting performance objectives could be found; and, finally, (d) model output and other relevant data were screened and analyzed, and an attempt was made to translate them into the measures and objectives that could be rationalized and quantified. Where statistical precision was not

possible, available evidence, logic, and the desirability of having a performance goal were considered, and goals or techniques are presented.

Throughout the study the aim was to determine which measures were important in gauging the performance of a support unit, the sensitivity of these measures to changes in the input variables, and the effects of overall system influence, particularly the effects of policy on support unit performance. The degree of success achieved was not uniform for a variety of reasons, as will be made explicit in the following pages.

SCOPE

In accordance with the Study Advisory Group's (SAG) guidance, the first phase of this study, reported on here, was concerned with performance measures at DSUs and GSUs. The functional areas surveyed were secondary item supply and maintenance. Because GSUs have no supply support mission, supply concepts and measures are obviously related to the DS level. With regard to maintenance, while the GS mission is analogous to DS, the data and objectives were treated separately. In addition, per SAG request, assistance was given to DCSLOG in the review of performance measures and goals for inclusion in a revision of Dept of Army (DA) Circular 700-18, "Logistics Improvements."[3]

ORGANIZATIONS VISITED

A listing of organizations visited is given in Table 2. Ft Hood and Ft Bragg were visited during November 1971, USAREUR during January 1972, and the Air Force during March 1972.

Ft Hood

Testing of CS_3 has been going on for some time at Ft Hood. This, together with the recent conversion to the Base Level Operating Information System (BASOPS) at installation level, has resulted in a supply system that differs considerably from those in use overseas. Both at Ft Hood and Ft Bragg, the co-location of combat and support units provides a smooth-working but probably atypical environment.

Within the III Corps structure the operations of the heavy and light equipment maintenance companies, especially with regard to their support to the divisions, were observed.

Table 2

UNITS VISITED

Location	Activity
Ft Hood, Texas	III Corps, G4
	13th Support Bde
	190th HEM[a] Co (GS)
	647th LEM[b] Co (GS)
	602d Maintenance Co (Repair Parts - DS)
	1st Cavalry Div (TRICAP)[c]
	Materiel Management Activity, DISCOM[d]
	2d Armored Div
	Materiel Management Activity, DISCOM
	124th Maintenance Bn (DS)
	CS_3 Test HQ; CSC Support Group
Ft Bragg, North Carolina	Directorate of Industrial Operations
	Installation Materiel Maintenance Division
	Installation Supply Division
	12th Support Bde
	269th Ordnance Group (GS)
	249th Repair Parts Co (GS)
	82d Airborne Div
	782d Maintenance Bn (DS)
	Materiel Maintenance Office
US Air Force	Directorate of Supply Services, Andrews AFB
USAREUR	HQ USAREUR, DCSLOG
	VII Corps: G4 and Support Command (COSCOM)[e]
	1st Armored Div HQ
	123d Maintenance Bn (DS)
	501st Supply and Transportation (S&T) Bn
	3d Infantry Div HQ
	703d Maintenance Bn (DS)
	71st Maintenance Bn (DS)
	6930th Civilian Labor Group
	8902d Labor Service Co (DS)
	8905th Labor Service Co (GS)
	95th Supply and Service (S&S) Bn
	303d Maintenance Bn (GS)
	182d LEM Co
	42d HEM Co
	87th Maintenance Bn (GS)
	903d HEM Co
	538th CC&S[f] Co

[a] Heavy equipment maintenance
[b] Light equipment maintenance
[c] Triple capability
[d] Division support command
[e] Corps support command
[f] Collection, classification and salvage

The 1st Cav Div (TRICAP) and the 2d Armd Div were visited.

The 2d Armd Div, which was observed during a field exercise, is equipped with a van-mounted IBM 360-40. CS_3 also calls for remote terminals, permitting the central processing unit to be located in rear areas. These terminals were not, however, in operation during November 1971.

The division logistics organization under CS_3, shown in Fig. 1, is similar to that found under DLOGS in Europe. Requests from customer units are routed through either the S&T Bn (for non-repair parts) or the appropriate forward (letter) company of the maintenance battalion to the data processing detachment (DPD), which is part of the DISCOM Materiel Management Activity (MMA). All companies of the maintenance battalion, including the HQ and A Co, are treated as storage locations. All demands, including those for NORS equipment, GS stores, and direct exchange (DX) replenishments, are recorded on the computer at the DPD. In DLOGS, however, DX and aviation supply actions never are recorded on the computer.

With reference to the GS organization at Ft Hood, shown in Fig. 2, there are two distinct activities under III Corps: the 13th Sup Bde, which constitutes GS maintenance, and the Directorate of Industrial Operations (installation level) for depot level maintenance. The 13th Sup Bde embodies GS maintenance for divisional units (through the 190th HEM and 647th LEM), as well as DS supply and maintenance and GS maintenance for nondivisional units. DS supply is provided by the 565th Repair Parts Co of the 553d S&S Bn. There is no GS supply; requisitions from the divisions as well as those from the GSUs are processed at the Installation Supply Division. The 13th DPD is equipped with an IBM 360-30 and processes all supply information for the support brigade.

It is of interest to compare the Ft Hood configuration with that of the Seventh Army. Neither divisional nor corps support at Ft Hood is based on the umbrella concept; i.e., the higher supply echelon does not stock a line simply because it is stocked one or more lower echelons.

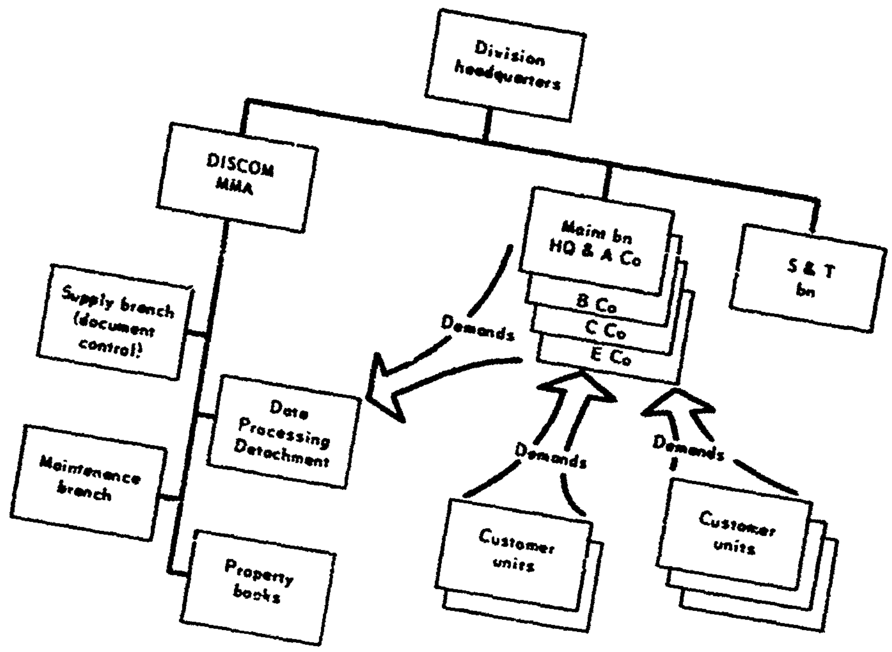

Fig. 1—Division Logistics Organization, CS_3

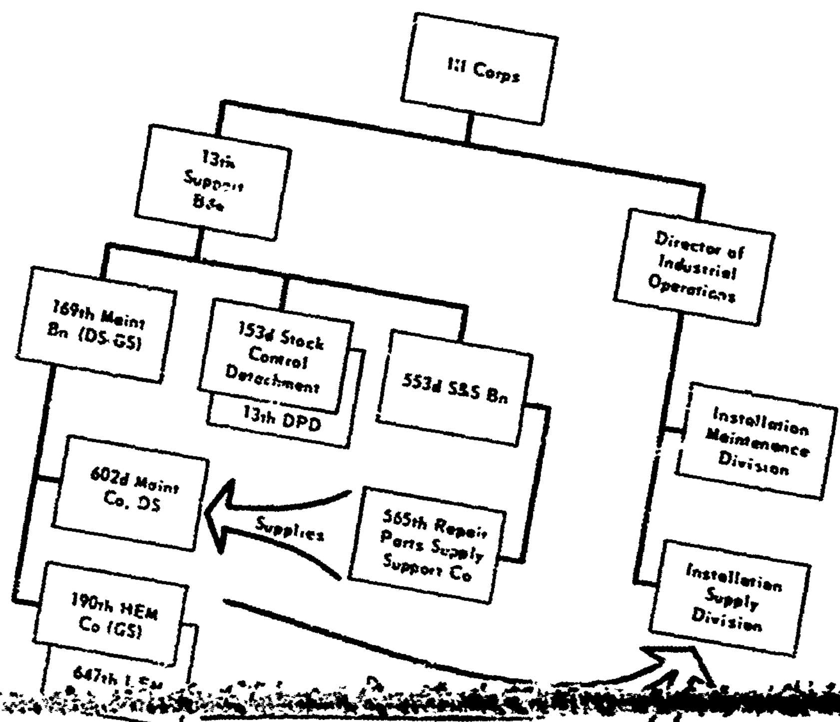

Fig. 2—GS Supply and Maintenance Organization, Ft Hood

RAC

GS backup to divisions at Ft Hood is limited. Though the 190th HEM and 647th LEM have GS maintenance missions in support of the divisions, more than half their work is nondivisional DS.

DX and QS operations are consolidated at the HQ and A Co of the maintenance battalion, a logical arrangement for co-located units, but different than observed in Seventh Army.

Another difference that is encountered concerns checking asset balances of all letter companies of the maintenance battalion before passing an unfilled requisition. Except for high priority requisitions, if neither the designated primary nor secondary letter company can fill, the other companies are not checked for assets before passing the requisition to installation level. No cross-leveling is possible between divisions since there is no record of assets below post.

Ft Bragg

At Ft Bragg, the XVIII Abn Corps, the 82d Div, and post installation were visited. In contrast to Ft Hood, there is a DX operation at installation level at Ft Bragg, although little of the DX maintenance performed there is done for the 82d Div.

The organization for logistics within the 82d Abn Div is shown in Fig 3. Instead of forward support companies, the maintenance battalion has two primary companies. A Co handles all maintenance except for aviation, through a main platoon for nonautomotive requirements and three forward platoons for automotive requirements. Most demands through these platoons are recorded on the Univac 1005; [illegible] requisitions through B Co are recorded [illegible] is essentially the same organization [illegible] in Seventh Army, except that letter [illegible] or platoons of the A Co provide DS maintenance.

Corps logistics at Ft Bragg is quite similar to that at Ft Hood (see Fig 4). The Directorate of Industrial Operations provides depot level maintenance, but mostly to nondivisional customers. GS maintenance support to the division only occurs for deadlined M551 (Sheridans) from the 4/68 Armd Bn, when these are beyond the maintenance capability or capacity of the 782d Maint Bn. As noted, there is GS supply at Ft Bragg, but it is practically limited to nondivisional support.

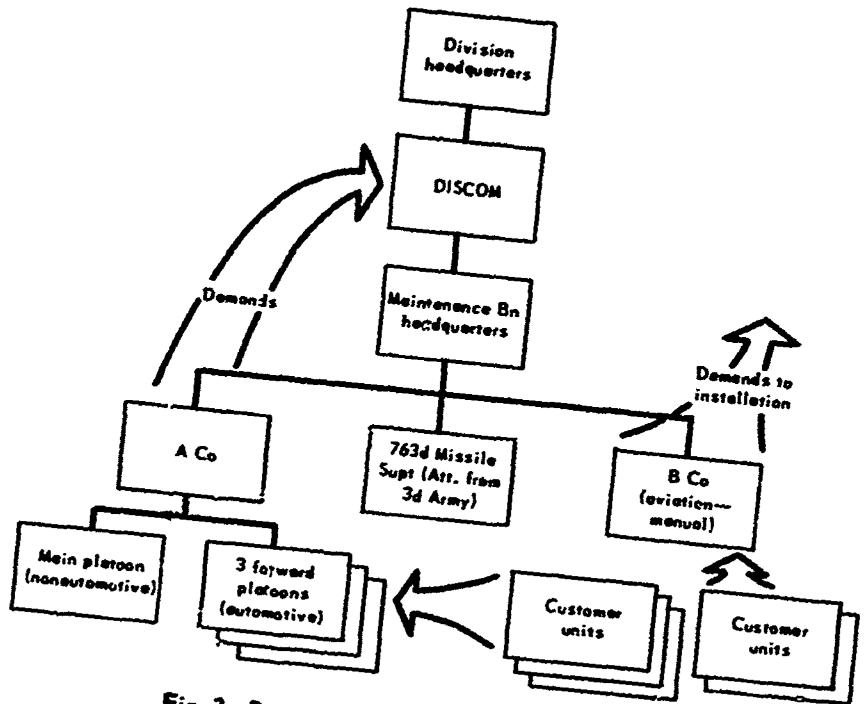

Fig. 3—Division Logistics Organization, Ft Bragg

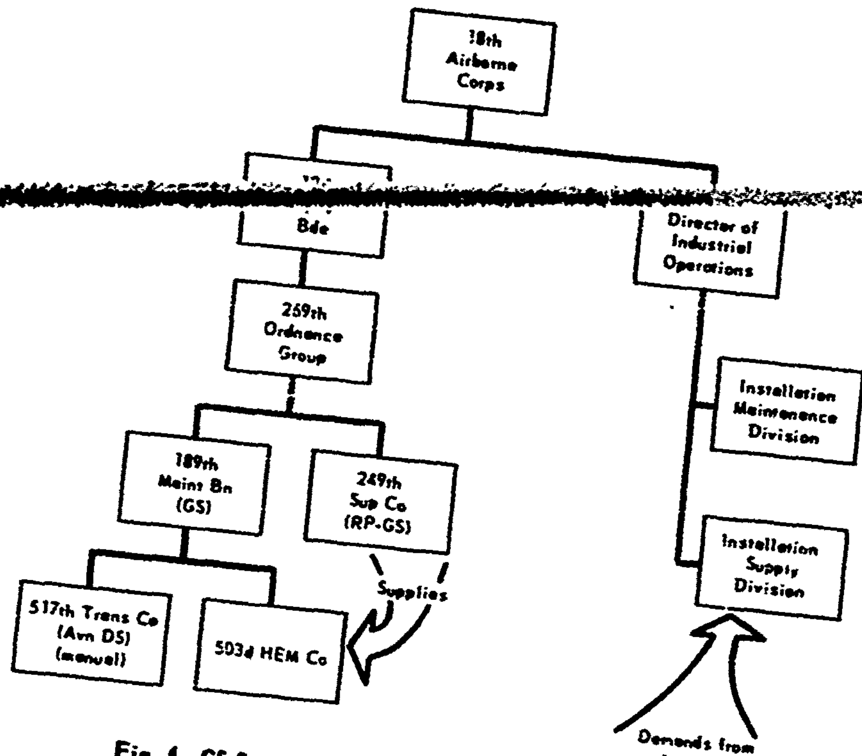

Fig. 4—GS Supply and Maintenance Organization, Ft Bragg

Seventh Army/USAREUR

Starting with the DCSLOG USAREUR, the headquarters of VII Corps, its COSCOM, and the 1st Armd Div were visited before going to the divisional and corps support units shown in Table 2. Supply support in Seventh Army follows the umbrella concept, higher echelons backing up the stocks of those below. Maintenance support comprises the traditional divisional DSUs with corps backup GSUs.

In terms of the unusual, two units should be mentioned, the 6930th Civilian Labor Group and the 903d HEM Co. The 6930th is a group of long standing. Members carry simulated military ranks, and the unit is so integrated into VII Corps operations that it goes on maneuvers and exercises with the regular US troops.

The 903d HEM Co was set up as a mini-depot for engineer equipment during 1970. Parts excess to unit needs are routed there, sorted, and identified for reissue or, if indicated, scrapped. All requisitions in the corps area for scoop loader, rough-terrain forklift, and full-track tractor repair parts clear through this company. Thus a corps-wide consolidated demand history is built up, significantly increasing the chances that these typically low-demand items will reach required stockage criteria and hence be stocked.

US Air Force

At Air Force HQ and Andrews AFB, supply and maintenance policies, procedures, and operations were noted. Visibility and control of secondary item stocks are reportedly excellent. This is attributed, in large part, to the fact that computer hardware and software packages are uniform at all bases throughout the world. The Air Force manages centrally and intensively some 162,000 Federal stock numbers (FSNs), accounting for roughly 90 percent of the value of secondary item stocks.*

The stockage list at Andrews AFB comprises about 65,000 FSNs, nearly equivalent to an Army theater stockage list.

*The Army SIMS (Secondary Items Management System) is analogous to this program.

DATA BASE

The data obtained by the study team in the field were derived from interviews, hard copy (microfilmed), and magnetic tape records. These are summarized in Table 3. They represent basic files, the kinds that are rarely transmitted out of the unit, let alone corps or theater. Additional data on units visited and others as well were obtained (and used in the analyses that follow), from official documents, unpublished memos and the considerable data bank at RAC. These sources provided the inputs to model runs and analyses undertaken. Since the aggregation of information when tied to unit identification might become sensitive, unit designations in tables and figures have been deliberately masked.

The data vary in quality and quantity, reflecting more the unit commander and personnel than DA, theater, or division regulations and policies. As will be evident in Chap. 5 on maintenance measures, empirical data do not always support logical hypotheses. Nonetheless, it is believed that the data base used is as complete and valid as is obtainable within reasonable resources and constraints.

CURRENT POLICY

Logistics performance measures and standards are prescribed or suggested in a body of Army regulations, circulars, and similar documents. In the aggregate they comprise current Army policy. A few examples are given in Table 4. Others are discussed in relevant portions of the chapters that follow.

The need to husband resources while providing proper logistics support under the combined pressures of restricted budgets and the Vietnam requirements led to the issuance of an Army policy statement that attempted to combine and coordinate guidance and goals previously contained in the types of documents cited above. The statement referred to was DA Circular 700-18, "Logistics Improvements,"[3] first issued in November 1969 and updated several times since.

Inputs to the circular notably on stockage policy, have been provided by the RAC study team to DCSLOG. It is anticipated that

Table 3

REPORTS AND DATA COLLECTED

Location	Report or data
CONUS	Supply
	Document Registers - DA 2064
	DX Stock Accounting Records - DA 3029-R and NCR 500 Ledgers
	DX Stockage Lists
	Shop Stockage Lists
	Maintenance
	Job Order Registers - DA 2405
	Job Orders (Sample) - DA 2407
	Materiel Readiness
	Deadline Data - DA 2406 and Computer Listings
	Performance Indicators
	Supply Performance Report, CS_3
	Installation Management Report, Ft Bragg
	Status Report, Project CLEAN, Ft Bragg
	Backlog Status Report 2d Armd Div, Ft Hood
US Air Force	Supply
	Stockage Procedures
	Economic Order Quantity (EOQ) Policies
	Controlled Items Procedures
	Maintenance
	Procedures and Standards
USAREUR	Supply
	Stock Accounting Records (DX, ASL, and QS, where manual)
	Reports of Supply Activity (ROSA)
	Stockage Lists (DX, QS, Country Store, etc)
	DX Activity Records:
	Turn-in and Issue Report
	Document Register
	Dues-out Records
	User-unit Demand History Files (1st Armd Div)
	Procedures
	Tactical Maintenance Control System (TMCS)
	COSCOM Management System
	USAREUR Supplement to QS Store Procedures
	Miscellaneous Standard Operating Procedures
	Maintenance
	Job Order Registers - DA 2405
	TMCS Maintenance Status Reports
	Open Work Order Registers
	One month of TMCS (on tape)
	Mandatory Recoverable Items List
	Materiel Readiness
	Materiel Readiness Reports - DA 2406
	Deadlining Parts Lists (TMCS)
	Reportable Items List Operational Status (RILOS)

Table 4

EXAMPLES OF CURRENT PERFORMANCE MEASURES/STANDARDS

Document[a]	Measure/standard	Comment
1. Dept of Defense Instruction No. 4140.39, "Procurement Cycles and Safety Levels of Supply for Secondary Items," 17 Jul 70[4]	Average number of days delay in the availability of materiel	For use at Inventory Control Points (ICPs) in determining procurement cycles and safety levels
2. AR 11-10, "Logistics Performance Measurement and Evaluation System," Nov 70[5]	Number of lines outstanding 1 to 30 days old, 31 to 90 days old, etc	App A-7, "Reduction of Back-orders," AR 11-10
3. AR 750-52, "Maintenance of Supplies and Equipment, Equipment Operationally Ready Standards," 29 Jul 71[6]	Weighted average objectives; percent of possible days that equipment is operationally ready or not ready	Applied to items reportable under TM 38-750,[40] App C
4. TOE 29-36E, "Headquarters and Main Support Company, Maint Bn, Armd Div," 15 Jul 63[7]	Mobility; 100 percent mobile	P 3 under "Capabilities"
5. AR 710-2, "Inventory Management, Materiel Management for Using Units, Support Units, and Installations," Aug 71[8]	Stockage goal: maximum of 30,000 lines at installation supporting a division or equivalent	Par 3-27
6. DA Cir 700-18, "Logistics Improvements," 7 May 71[3]	Demand accommodation, DSU/GSU, goal: variable by commodity, average 80 percent	P 7, under "Supply Management Performance Targets/Goals"

[a]These documents plus those cited under References are indicative but not exhaustive of official guidance on supply and maintenance measures/standards/objectives.

many of the measures and objectives detailed in this report will appear in future editions of the circular.

Until the rather recent development of simulation models, especially those representing the complex secondary item supply system, it has not been feasible to relate quantitatively the impact of one or more important variables on others. For example, in the past, stockage policy in terms of the size of a stockage list, the rules for an item getting on and staying on the list, and the performance expected from these rules and the list was established independently. It is now possible to demonstrate and measure many of these relations and hence avoid conflicting or impossible objectives. Indeed the supply system measures discussed and proposed in this report have in large part been rationalized or developed through the use of models evolved at RAC. A short description of the principal models follows.

MODELS USED IN PERFORMANCE ANALYSES

Stockage Criteria Model

The Stockage Criteria Model (SCM) is a special-purpose analytical model that is concerned with the rules governing what to stock at a supply point. This model does not deal with the depth of stockage, i.e., the quantity of items to be stocked. The SCM is computerized and is programmed in FORTRAN for use on the CDC 6400 computer. An early version of the model was developed during a previous RAC study. Refinements and modifications have since been made, which make the model more flexible and efficient.

Inputs. The required inputs to the model are two in number. The first input, a demand history pattern, takes the form of a demand frequency distribution for the unit(s) whose requirements provide the basis for developing a stockage list. Detailed demand frequency distributions for three Army divisions are shown in App B. These distributions reflect the requirements of the customers of the division's DSU. Only those items stocked on the basis of demand (i.e., demand-supported) are considered in this analytical model. Items stocked in support of new equipment and for other contingencies are additional elements of a DSU's ASL.

The second input to the model is an array of the various stockage criteria one may wish to evaluate. These criteria are the rules that govern the addition and removal of individual FSNs to and from the demand-supported portion of the stockage list. The addition rule refers to the number of demands (requisitions) required in a specified period of time (usually 1 year) to add an item to the stockage list. The retention rule refers to the number of demands required in the same time period to retain an item on the list once it has been added. Thus, the 6-3 addition-retention criteria refer to the policy requiring six demands for addition to a stockage list and three demands for retention on the list.

Outputs. For each criteria set processed through the model, the following measures are produced: the predicted size of the stockage list (number of FSNs), the expected turbulence (number of additions and deletions per time period expressed as a percentage of the list size), and the predicted demand accommodation to be afforded by the stockage list. By comparing the results obtained for the numerous different sets of criteria considered within the model, the analyst has a wide range of alternatives from which to choose the most appropriate for his particular purpose. Once such a selection is made, the indicated criteria can be readily introduced within the context of the Army's present supply policy.

Supply Point Simulation Model

The Supply Point Simulation Model (SPSM) is a probabilistic model designed to simulate the supply transactions of a supply point that operates in accordance with prescribed supply policies and to report the resulting supply performance, workloads, and costs. The model was designed to facilitate analysis of how supply policies, resupply time, and demand pattern interact to affect performance statistics. The SPSM is programmed in FORTRAN and is operational on the CDC 6400 computer.

Inputs. Six kinds of input data are required to describe the supply transactions at a supply point: these include cost parameters, simulation time, inventory policy parameters, stockage policy parameters, demand patterns, and resupply delay time. Cost parameters include the fraction of annual inventory value incurred as holding

cost, the cost per order submitted, the cost of the delay caused by backordering a demand for a quantity of one, and the item price. Present Army policy calls for a holding cost of 40 percent and a cost per order of $10. Cost of delay is not utilized in the model runs described herein.

Simulation time is the time length for which statistics are collected and reported. Five years of simulation time were used in the model runs of this analysis.

The inventory policy of the supply point may be described in terms of the requisitioning objective (RO) and reorder point (RP), both expressed in days. Stockage policy refers to the specification of forecasting parameters--the control period and review interval, and addition-retention criteria.

Demand patterns--frequency of demand and quantity demanded--are expressed as standard analytically defined distributions. These distributions are based on the empirical demand data illustrated in App B. A resupply delay time distribution was developed using data from the DSS, Europe. That distribution is illustrated in App B.

Outputs. For each simulation run, more than 40 performance measures are obtained as output. A detailed list of these outputs may be found in App B. Some of the measures shown, while available from computer simulation, may not be readily measurable in the day-to-day operation of the DSU.

REPORT CONTENT

In Chap. 2 the general concept of performance measurement is treated, particularly with reference to the mission of a DSU. Also, specific measures are defined, and their relations to each other are explained. Chapter 3 deals with the major policy-related measures: those affected by stockage breadth and depth policies and the impact of quick supply criteria. Chapter 4 is a discussion of other measures and applicable objectives. The main concepts covered include DX, readiness, and unit mobility. Finally, Chap. 5 represents an attempt to rationalize empirical maintenance data into a set of performance goals.

Chapter 2

PERFORMANCE MEASUREMENT CONCEPTS AND THEIR RELATION TO DSU MISSION

INTRODUCTION

As explained in Chap. 1 the primary emphasis of this study is to isolate the most effective, most meaningful measures of DSU performance in order to enable the DSU commander to determine how well (or how poorly) his unit is performing its mission. To that end, this chapter describes in some detail the mission of a DSU and its relation to the missions of the units it supports and the activities that support it. Thereafter the significant measures of performance that are either currently available or suggested will be described. Where possible, these are quantified in Chaps. 3 and 4 using field experience data from CONUS and USAREUR.

Currently hundreds of different measures are in use or proposed for maintaining control over performance of the supply and maintenance systems. However, no means is readily available, save subjective judgment, for assigning relative importance to these myriad measures. Before their relative importance can be assessed, the interrelations among the key elements that affect performance had to be understood and quantified. The study work statement recognized this need.[2] Once these interrelations are quantified, the sensitivity of one measure to likely or predictable variations in other measures can be addressed.

THE USER-UNIT MISSION

At the user-unit level, preparedness for combat is the primary mission, indeed the reason for maintaining an Army. Materiel preparedness is the responsibility of organizational maintenance, whose mission is to "sustain materiel readiness of using activities."[9] To accomplish that mission, certain supply and maintenance functions are required

of the battalion. For those equipments requiring a degree of repair that is within the prescribed capabilities of the organizational level, the organization must request and obtain the required repair parts, kits, modules, or components; accomplish the necessary repair; and return the equipment to an operational condition. For the time during which the equipment is out of commission, it is referred to as "not operationally ready." Thus the primary measure of organizational supply and maintenance effectiveness is operational readiness (OR), as defined below.

Operational Readiness

Definition. OR is defined as the capability of a unit or equipment to perform the missions or functions for which it is organized or designed.[10] When a piece of equipment is "not operationally ready" (NOR), the cause is assigned either to supply (NORS), when the required parts are not available, or to maintenance (NORM). Clearly neither of these causes is completely controllable by the unit commander. Yet there are ways to determine whether the unit is performing its mission satisfactorily. This report endeavors to identify those means.

Selected Army organizations and activities are required to report their OR status quarterly to the Army Materiel Command Logistics Data Center (LDC) in Lexington, Ky. From these quarterly status reports a summary report is compiled entitled "Unit Equipment Status and Serviceability Report."[11] When the equipment is NORS or NORM at the organizational level, i.e., when the required repair may be accomplished at organizational level but either the parts are not yet available or the maintenance is not yet completed, the NOR status is "assigned" to the organization itself. When the job has been evacuated to a higher echelon for repair, the NOR status is assigned to the support level.

The Importance of OR Rates. As required by regulation, OR standards are used to measure the performance of equipment that is the responsibility of each unit commander. Standards are established individually for Army divisions, brigades, and nondivisional units. When the actual OR rate fails to meet the standard for that command by 5 percent or more, major commanders must provide an analysis of the reasons.[6]

Derivation of NORS and NORM. Knowing the number of equipments on hand (of a particular type) and the number of days in the quarter (including weekends and holidays), the possible number of equipment-days is computed. Similarly the nonavailable equipment-days may be computed. The quotient of $\frac{\text{nonavailable equipment-days}}{\text{possible equipment-days}}$ yields the NOR rate. This may be further divided into the NORS and NORM rates, and according to whether the NOR status is assigned to the organizational or to the support level.

Source of Data. The unit commander obtains the data required to compute the NOR rates from the so-called "morning reports"—daily reports from the maintenance section that indicate the number of vehicles/equipments that are awaiting shop, awaiting parts, or in shop. From these, and from the property book records indicating the number of equipments on hand, the NOR rates are readily computed.

Relation to Other Measures. To a large extent, the NORS rate reflects the capability of the supply system to respond to the demands placed on it. Beyond ensuring compliance with the prescribed procedures, the unit commander has no means of expediting the requisitioning process. However, to the extent that those procedures are not adhered to, the commander may indeed be to blame for the system's failure to be responsive. If, for example, the required part is to be locally fabricated or is to be obtained from the nearest cannibalization point, and the unit requisitions the part instead, then the system is certainly not at fault.

The NORM rate will, in most cases, reflect the repair capability and efficiency of the maintenance unit itself. Barring unusual activities, such as more than the normal number of field exercises, that would cause an increased workload, the major factor affecting maintenance performance will be the amount of time it takes to do the job. This in turn should be directly relatable to the appropriate allocation of personnel resources to the job. This subject is discussed in much more detail in Chap. 5.

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THE DSU MISSION

The DSU is in operation primarily for the purpose of providing supply and maintenance support to designated units. This is accomplished by "(a) exchange of serviceable for designated unserviceable end items/modules/piece parts; (b) repair on-site or for return to user of end items/modules which can be effectively and efficiently accomplished... and which will restore a high degree of reliability to the end item/module; (c) distribution of organizational maintenance repair parts to supported...activities; (d) provision of technical assistance."[9] Thus the basic mission of the DSU is twofold: to provide supply and maintenance for supported units The accomplishment of this mission implies the need for mobility; DSU Tables of Organization and Equipment (TOE) confirm this, by specification of "100 percent mobility."[7]

Accomplishment of the mission is achieved through a mix of functions performed by the supply and maintenance elements of the DSU. Table 5 lists these functions under three basic headings: Supply, Maintenance, and Transportation. Several of the functions have both supply and maintenance implications. Two such functions are DX support and maintenance float, which overlap both supply and maintenance.

Table 5

PRINCIPAL DSU FUNCTIONS

Type of function	Function
Supply	Shop stocks QS store Tech supply DX
Maintenance	Float Customer DS DX Modification workorder (MWO) installation Local fabrication Cannibalization
Transportation	Relocation of supply and maintenance when required Evacuation of unserviceables

Indeed, even those that are normally considered to be strictly maintenance functions rely heavily on the supply activity, as may be seen in Chap. 5. Those functions relating most directly to supply are covered in Chaps. 3 and 4; maintenance-related functions are discussed in Chap. 5.

Shop Supply

Shop supplies consist of expendable items that are routinely consumed during maintenance operations. Usually common hardware items such as standard screws and nails, miscellaneous supplies such as tape and solvents, and raw materials are included on the shop stockage list. These may or may not be considered part of the DSU's ASL, dependent on the discretion of the local commander. Normally, detailed accountability is not required for shop supplies, especially with regard to the recording of individual demands. Nevertheless, although wholesale free issue of these items is generally practiced, requirements information is of necessity tabulated, as formal requisitioning is required for replenishment.

In cases where individual demands may be recorded at the DSU for shop supplies, there is no need to consider it separately; it is distinguished herein only to underscore the need to measure the performance of said function where it does exist as a separate entity.

QS Stores

The QS function is designed to provide easy access to fast movi low unit cost lines. In QS no formal accounting of individual demands is maintained, resulting in a considerably simplified system from the customers' standpoint but, as with shop supply, causing difficulty in terms of performance measurement.

There are currently several variations, proposed or in operation,[12,13] of the basic concept of QS operations. Generally these specify that QS lines must meet the demand criteria required for inclusion on the ASL and must have a unit price of no more than $5. Over-the-counter issue, with no requirement for formal customer requisitions, makes QS an attractive procedure both to the customer and to DSU personnel.

A detailed analysis of two current and different QS systems is described fully in Chap. 3. The advantages and disadvantages of each

are considered, and several alternative forms of each of the two policies are considered and analyzed. The overall system performance resulting from each is derived, as is the contribution of the QS store segment to the overall data.

Measures of QS Performance

The basic advantage of the QS concept, simplicity, is also its basic shortcoming with respect to performance measurement. The procedural simplifications that constitute QS eliminate the data sources for the more conventional performance measures. Nevertheless it is felt that, because QS potentially represents a very large portion of the total DSU supply activity, measurement of its performance is required.

The following performance measures are suggested for QS. Obviously, each requires data not currently available because detailed records are not maintained. Thus a sampling technique or a manual counting system will be needed.

QS Fill Rate. QS fill rate is defined as the percentage of customer requirements for QS lines that are immediately available from assets on hand in the QS store. Customer requirements for a particular line may be defined as the number of times that line is required, or as the total quantity of that line required, during a given time. Clearly, QS fill rate constitutes the ultimate measure of the effectiveness of the QS store. From the customers' viewpoint a high fill rate would mean that the parts are there when they are needed. QS fill rate is not directly calculable because the necessary data are not available. This fact, however, does not diminish the desirability of the QS store concept. Thus other measures are required that will gauge the effectiveness of the QS operation without disturbing the simplicity of the procedure itself.

QS Zero Balance. Just as the percentage filled cannot be calculated, neither can its complement, the percentage not filled. However, QS zero balance represents an alternative that will at least provide an indication of the complementary measure: the nonavailability rate. Lines at zero balance are nonavailable for issue; thus the zero balance can be considered equivalent to nonavailability.

QS zero balance is the percentage of QS lines for which there are no assets on hand at any particular time. The required data may be obtained through a periodic visual inspection of the QS bins.

QS Zero Balance with Dues-out. Zero balance is a meaningful measure of QS store performance because it quantifies nonavailability. However, nonavailability is of no consequence when there are no requirements for the line during the time it is nonavailable. Thus a more detailed measure, QS zero balance with dues-out, is developed to indicate those cases of nonavailability for which outstanding requirements are known to exist. A simple manual review of the master inventory record (MIR) at the DSU will reveal such cases, which may be used in calculating the overall QS zero balance with dues-out. For those DSUs that are not automated, the manual dues-out file may be consulted. This should not represent a substantial workload, as the nonautomated DSUs are generally those of relatively small volume of activity.

Caution must be exercised in the interpretation of QS zero balance with dues-out. Unless the requirement for a QS line is of high priority [issue priority designator (IPD) 01-08], the request is held at the DSU pending arrival of replenishment stocks. Thus the MIR will reflect only those QS dues-out for IPD 01-08. These of course will be the most critical cases of nonavailability. Although it would require somewhat more effort at the automated DSUs, research of the QS dues-out file will reveal those cases of routine priority requests for which there are outstanding unfulfilled requirements.

Tech Supply

The tech supply function of the DSU is the classic supply function: in the broadest terms it refers to the requisitioning, receiving, storing, and issuing of repair parts and related supplies to customer units. The tech supply section's customers include all authorized user-units and all maintenance functions of the DSU itself. Thus the shop supply (if a separate function) requests replenishment through tech supply. Any parts needed to repair unserviceable DX components or maintenance float end items, raw materials used in the local fabrication of parts and components, parts required to repair unserviceable end

items not reparable by the owning unit, and MWO kits are all ordered through the tech supply section. This broad statement excludes, of course, any parts that are available through the QS store, but even replenishment requisitions for these are processed by the tech supply. In addition to the above tasks the main support companies of divisional DSUs in certain theaters (notably USAREUR) provide supply support to the forward companies of the same battalion. This is the so-called "umbrella concept."

Measures of Tech Supply Performance

Tech supply is the primary source of supply for most parts and components and the channel through which resupply (replenishment) is obtained for shop supply and QS. Although the value of annual requirements for parts requisitioned through tech supply is considerably less than that of DX or maintenance float, its performance directly affects these functions. Thus the tech supply function is the single most important of the DSU's supply mission. Because of this, several measures are suggested for use so that locally controllable factors may be distinguished from external factors such as maintenance performance or the efficiency of the wholesale supply system. That is, the effects of compliance (or failure to comply) with accepted rules and procedures have to be isolated from overall system deficiencies in order to gain an appreciation for actual tech supply performance.

Tech Supply Fill Rate. Tech supply fill rate is the percentage of total valid demands received, for stocked and for nonstocked lines, that experience immediate fill. It is the primary measure of the effectiveness of tech supply operations.

NORS and the Tech Supply Fill Rate. NORS, on the other hand, measures the combined effects of the efficiencies and deficiencies of all levels of the supply system, and even the maintenance and transportation systems. It is conceivable that the NORS rate may be high while the DSU tech supply function is actually performing more efficiently than usual.

In order to arrive at an objective for tech supply fill rate it is essential to ascertain its relation, if any, to the higher level measure, NORS. If such a relation can be established, the level of

NORS that can be tolerated without adverse effects on mission accomplishment will dictate boundaries of tech supply fill rate attainable.

To develop such a relation empirically, two sources of data were utilized: monthly supply statistics for July 1970 through March 1972 provided tech supply fill rates; "Unit Equipment Status and Serviceability Reports"[11] for the same period provided the NORS statistic. The latter data are reported on a quarterly basis; hence to make the two sources compatible, the monthly statistics were converted to quarterly figures. Table 6 shows the resulting data for 2 divisions.

These data are plotted in Figs. 5 and 6. Least squares analyses were run on the data inputs, and the resulting regression equations are shown by solid lines. Confidence limits (95 percent) are denoted by dashed lines. The indexes of determination for the respective divisions are considered to indicate significant relations between the variables, i.e., tech supply fill rate and NORS. Thus, if a commander specifies a NORS rate below which his unit must not fall, the tech supply fill rate required to obtain that level would likewise be defined. That is, as tech supply fill rate decreases, NORS increases. A decrease in tech supply fill rate from 60 to 40 percent would mean an increase from 5 percent NORS to 8 percent in division A, and to 11 percent in division C.

Tech supply fill rate is examined in detail in Chap. 3 which describes the analyses used to derive an appropriate DSU standard for it and for the various other related measures that affect it. In addition the constraints that are imposed by resource limitations and become manifest in the form of supply policies are evaluated in relation to the ability to achieve desirable levels of performance.

Supply System Response Rate. SSRR is the sum of fills provided immediately, outstanding backorder releases, and receipts of quantities due in for nonstocked lines, expressed as a percentage of cumulative commitments. The SSRR therefore combines a measure of the efficiency of the DSU itself with a measure of the efficiency of the supply system's response to properly documented requisitions that cannot be immediately filled at the DSU. (Fills provided immediately are also used in the tech supply fill rate.)

Table 6

RELATION BETWEEN TECH SUPPLY FILL RATE AND NORS FOR 2 DIVISIONS
JULY 1970-MARCH 1972

Period	Division A			Division C		
	Net requests[a]	Tech supply fill rate,%[b]	NORS,%[c]	Net requests[a]	Tech supply fill rate,%[b]	NORS,%[c]
July - Sep 70	—[d]	41.0	8.8	—[d]	39.0	12.5
Oct - Dec	62,971	36.0	9.2	59,480	38.7	11.2
Jan - Mar 71	47,483	47.3	6.7	61,155	45.7	7.0
Apr - Jun	26,872	58.2	6.4	32,169	49.8	7.6
Jul - Sep	45,373	47.3	—[d]	33,393	52.8	5.9
Oct - Dec	—[d]	48.2	5.9	—[d]	55.3	7.7
Jan - Mar 72	—[d]	47.6	6.2	—[d]	51.8	8.2

[a]Net requests equal total requests minus rejected requests.

[b]Tech supply fill rate presumes no fill from nonstockage list (NSL) assets. See Chap. 3 discussion on the influence of NSL fill on tech supply fill rate.

[c]Includes both organizational and support level NORS.

[d]Not available.

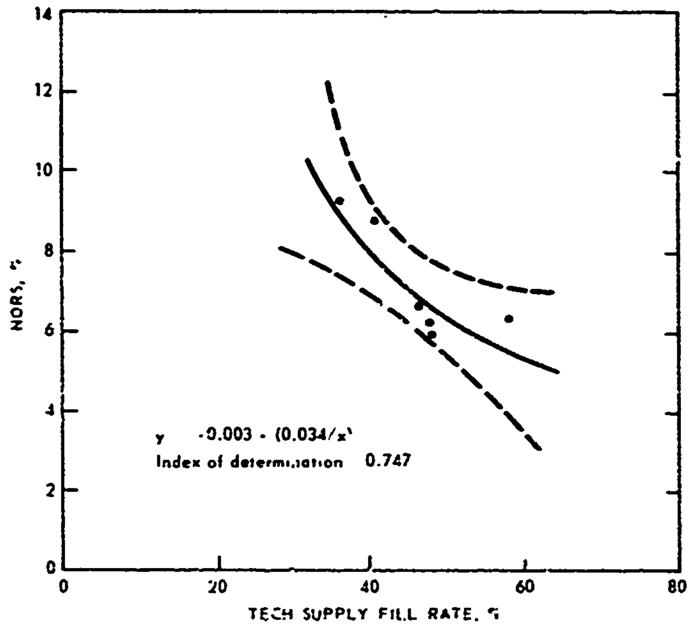

Fig. 5—Relation of Tech Supply Fill Rate to Combined Organizational and Support NORS, Division A, July 1970-March 1972

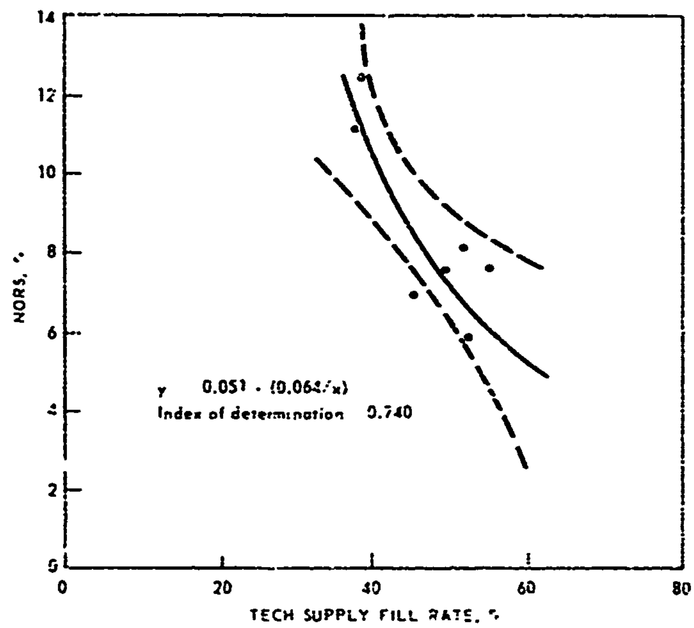

Fig. 6--Relation of Tech Supply Fill Rate to Combined Organizational and Support NORS, Division C, July 1970-March 1972

There is a tendency to place the onus of explanation of a low OR rate on the commander of the unit involved. When faced with this situation the unit commander will usually have the ready answer that the supply system is at fault - the required parts are not available. Such may often be the case, but verification of that fact is almost impossible except on a case-by-case basis. The measures of tech supply performance advanced herein are designed to provide an overview of the DSU's performance vis-a-vis that of the supply system. A high tech supply fill rate accompanied by a low SSRR would, for example, focus attention on the support provided to a DSU by the higher supply echelons. Thus the manager would have the advantage of at least knowing where to start looking for the cause of the problem. There is no doubt that overall system performance will be reflected in each of the pertinent measures discussed here; that is the reason for measuring each function in several different ways.

Deadliner Stockage Index (DSI). The DSI is the fraction of lines that are causing equipment to be deadlined for parts that appear on the stockage list of the DSU. Because equipments deadlined for lack of the needed repair parts are the sole contributors to NORS, stockage of (and assets on hand for) these deadlining parts is most desirable. Detailed analysis has demonstrated (see Chap. 4) that there is a high degree of recurrence of parts causing deadline. This infers a predictability that can be used to justify stockage of the deadliners to preclude future delays when the same part fails again.

Eventually the supply system may become sophisticated enough to permit stockage policy to be altered to accommodate potential deadliners in all DSUs supporting like equipment. For example, once a particular equipment type has been deadlined more than X times for lack of the same repair part anywhere in the world, that part will be stocked by all DSUs supporting that equipment type.

Other Measures of Tech Supply Performance. In order for the tech supply function to operate as it is designed, three basic requirements must be met: (1) the supply system must be responsive, (2) DSU personnel must follow prescribed procedures, and (3) supply policy must be developed in cognizance of its effects on and inherent limitations of attainable performance.

The following listed performance measures are described fully in Chap. 3. Each is intricately related to all the others and is in turn an important contributor to the overall tech supply fill rate. Any change in one will occasion changes in one or more of the others and, unless supply policy is altered at the same time, will change the tech supply fill rate. When tech supply fill rate, the SSRR, or the DSI exceeds its expected bounds, the manager can look to these measures first in hopes of detecting the cause:

1. ASL size—the number of lines on the ASL.

2. ASL demand accommodation—the percentage of total valid demands received by the DSU that match the ASL.

3. Zero balance with dues-out—the fraction of ASL lines at zero balance for which dues-out are recorded, i.e., for which there are recorded unfulfilled requirements.

4. ASL (NSL) fill rate—the fraction of total valid demands received for stocked (nonstocked) lines that experience immediate fill. The sum of ASL and NSL fill is the determinant of tech supply fill rate.

5. ASL (NSL) dues-in greater than 180 days—the fraction of total dues-in for ASL (NSL) lines that have been due in for more than 180 days.

6. SOH to RO ratio—the quantity (or dollar value) of current stock on hand for ASL lines divided by the RO quantity (or dollar value).

7. Acquisition value of excesses—the acquisition value of the quantity of assets in excess of twice the RO quantity, for ASL lines. Acquisition value of excesses for a given line is the excess quantity on hand multiplied by the unit price of the line.

8. Indicator of nonidentifiable excesses—the number and quantities of repair parts and maintenance-related nonidentifiable lines that are excess. Nonidentifiable excesses are those resulting from turn-ins and cancellations of nonstocked lines that cannot be identified by a valid FSN or part number.

9. ASL turbulence—the amount of fluctuation in the composition of an ASL. It includes additions of lines to and deletions of lines from the ASL.

Effects of Policy Alterations on Tech Supply Performance. Because of the close interdependence of supply policy and the level of supply performance attainable, the supply policies in force or proposed can place undesirable restrictions on the performance achieved. Much of the analysis in Chap. 3 concentrates on this problem in an effort to portray what is achievable and to suggest policy alternatives where appropriate (when the level achievable appears to be unacceptable).

The following list of policy terms and their definitions may be helpful in understanding the policy alternatives discussed in Chap. 3:

1. Stockage breadth - the number of different lines (FSNs) on the DSU's ASL. This term is almost interchangeable with ASL size. Breadth indicates the policy; size implies the effect of the policy.

2. Addition-retention criteria - the rules that determine which lines to stock, based on the frequency of demands experienced.

3. Stockage depth - the quantity of items (parts, or pieces) stocked at a supply point, also expressed as days of supply. This term is equivalent to RO. It is composed of the safety level, the OST level, and the operating level.

4. Safety level - the quantity of parts stocked to permit continuous operation in the event of minor interruption of normal replenishment or unpredictable fluctuations in demand.

5. OST level - the portion of the RO representing the quantity consumed during the time required for replenishment.

6. Operating level (OL) - the quantity required to sustain operations in the interval between requisitions or the arrival of successive shipments.

Effects of OST on Tech Supply Performance. Superimposed on the performance provided by tech supply and on the responsiveness of the system is OST, the millstone of the supply system. Whenever actual OST fails to coincide with the days of supply used to compute the OST level, the resultant performance will differ from that predicted. In fact, empirical OST influences virtually every measure of performance. Therefore it is most important to maintain a continuous awareness of OST performance in order to understand the inevitable fluctuations in the other performance measures and to help preclude unacceptable readiness rates.

No easy answer to the vexing problem of lengthy OST is readily apparent. To set a standard applicable to all DSUs would be folly; experience in individual situations is the only sensible approach. An earlier RAC report suggests a method that may be used to arrive at such a standard.[14]

DX

The DSU DX facility issues serviceable items to customer units in exchange for unserviceable items of the same FSN. DX lines are reparable assemblies, subassemblies, and components that are within the repair capability of the DSU, or of a higher supporting echelon to which they may be evacuated. They are also generally lines of high unit cost that are not available via routine requisitioning procedures.

Establishment of a DSU DX facility is currently not mandatory, but most DSUs have found that such a facility is beneficial. Stockage criteria for DX are prescribed by regulation[8] and are as follows:

1. Candidate line must be reparable, either at the DSU's maintenance facility, or be on the DX list of a supporting maintenance unit.

2. Repair must either be required or anticipated for the item.

3. For missile items, repair/replacement must be required at least 6 times per year for addition and 3 times per year for retention.

4. For all other items, repair/replacement must be required at least 12 times per year for addition and 6 times per year for retention.

5. Or, failing 3 or 4 above, the item must be mission essential, and be carried on the ASL.

The importance of DX as a source of supply has been repeatedly emphasized in Army policy.[3,8,15] Because DX stockage represents a large monetary investment and because a relatively high replacement rate is required to qualify for that stockage, there can be no doubt that DX performance is of considerable importance to the DSU commander.

Measures of DX Performance

DX Fill Rate. DX fill rate is the percentage of requests, for exchange of an unserviceable item for a serviceable one, that are immediately honored. Currently most DX facilities are not measuring their fill rate. In large measure this may be due to the difficulty in doing so. Like shop supply and QS, the formal records that could

provide the means of measuring fill rate do not exist. In lieu of such records a sensible scheme could be devised to keep track of DX fill rate, either through sampling techniques or by a relatively simple yes/no counting system. Although the suggestion may seem drastic to those concerned about overburdening the operation with paper work, it remains of crucial importance to retain visibility and control of these relatively expensive reparable items.

DX Deadline Index. The DX deadline index is defined as the fraction of total serial-numbered equipments deadlined for one or more parts that should be available from the DSU's DX facility. This measure quantifies the extent of the influence of inadequate DX support on a user's deadline status. It is a valuable indicator of whether the DX facility is operating satisfactorily.

Clearly, both performance measures described for the DX facility are heavily influence by the performance of the maintenance activity of the DSU. Nevertheless DX is a supply function;[8,16] it must (indirectly) rely on tech supply for the required repair parts, and the service it provides to its customers may be viewed by them as supply support. Good judgment in selecting the lines to place on DX, as well as careful calculation of the DX stockage depth based on realistic repair cycle times, is of utmost importance in sustaining high performance.

Maintenance Float

The maintenance float is primarily a maintenance function, and is covered in detail in Chap. 5. To the extent that the DSU issues float equipment to customer units in exchange for unserviceable equipment, however, it is also a supply responsibility of the maintenance battalion having a DS mission.[9,17]

Maintenance float end items are issued to replace unserviceable equipment when timely repair of the latter cannot be accomplished by the DSU. This procedure is intended to ensure a high level of OR at supported units. End items are selected for float only if they are mission essential and are authorized for field level maintenance. The float item is issued in exchange for an unserviceable only after it is determined that the unserviceable cannot be repaired by the DSU within specified maximum repair time limits, and then only based on priority of need and DSU commander discretion.

Maintenance Float Fill Rate. Maintenance float fill rate is the fraction of requests for issuance of a maintenance float in exchange for an unserviceable end item that are immediately honored. It is a measure of the capability of the maintenance element to keep ahead of requirements for float items.

Serviceability of Maintenance Float Assets. Serviceability of float assets is the fraction of total items authorized for the float that are currently in a serviceable, issuable condition at the DSU. This is a measure of the potential responsiveness of the DSU to float requirements.

DSU Customer Maintenance

DSU customer maintenance support embodies virtually all the maintenance tasks of the DSU. Unserviceable end items received in exchange for float items must be repaired and returned to the float; the float itself is thus a customer of the maintenance facility. Unserviceable DX items represent another maintenance mission; DX, too, is a customer. The primary measure of the effectiveness of the maintenance function is customer NORM. The primary measure of its efficiency is TAT.

TAT. TAT is the total time to repair an unserviceable piece of equipment and return it to the customer. Because work backlogs can cause delays that are felt by the customer, the total TAT includes the time awaiting shop, the time awaiting parts, and the time in shop. Each of these is considered in Chap. 5.

Other Measures of Maintenance Performance. Should TAT appear to be inexplicably excessive, the maintenance manager may wish to have other backup measures readily at hand in hope of understanding the problem and being able to take swift corrective action. A few secondary measures that would be helpful are listed below. Each is discussed in more detail in Chap. 5:

1. Job order evacuation rate - the fraction of total repair jobs received that are evacuated to a higher maintenance echelon. Evacuation is usually necessary either because of work backlogs at the DSU or because the required repair is beyond the capability of field level maintenance.

2. Parts backlog - really two measures: the number of jobs currently awaiting the arrival of needed parts and the estimated

man-hours required to complete the repairs once the parts are available.

3. Backlog awaiting maintenance - the number of jobs currently awaiting shop and the estimated man-hours required to perform the repairs.

4. Backlog in maintenance - the number of jobs currently in the shop and the estimated man-hours required to complete them.

5. Manpower utilization index (MUI) - the ratio of man-hours available to man-hours actually expended on maintenance.

6. Ratio of man-hours to time in shop - the ratio of total number of maintenance man-hours recorded on a job to total elapsed working hours that job was in the shop.

7. Average man-hours per job.

Other Maintenance Functions

1. MWO installation - alteration or modification of all equipments of a particular type, as directed by higher headquarters. No new performance measure is suggested for this activity.

2. Local fabrication - the local manufacture of parts and components is rarely accomplished at DSU level; thus the efficiency of this function is simply a contributor to the overall TAT and is not separately measured.

3. Cannibalization - the removal of serviceable parts or components from an unserviceable end item, in order to replace unserviceable parts on a similar end item. For DSUs relying on local cannibalization as a major source of fill, a cannibalization fill rate could be developed. Most DSUs observed by the study team do not rely extensively on local cannibalization.

SUMMARY: RELATIONS AMONG DSU FUNCTIONS AND PERFORMANCE MEASURES

The basic missions of the DSU are associated with basic performance measures: supply with NORS and maintenance with NORM. Each function may in turn be related to accomplishment of the supply and/or the maintenance mission, and each of these has one or more principal measures of the efficiency of its performance. Most of these are not mutually exclusive; indeed, to fully comprehend the significance of any one requires at least an awareness of its relations to the others and to the various secondary measures available.

Figure 7 is a simplified diagram of the interrelations that exist among the functions and their pertinent measures. In a sense it is a summary of the concepts presented in this chapter.

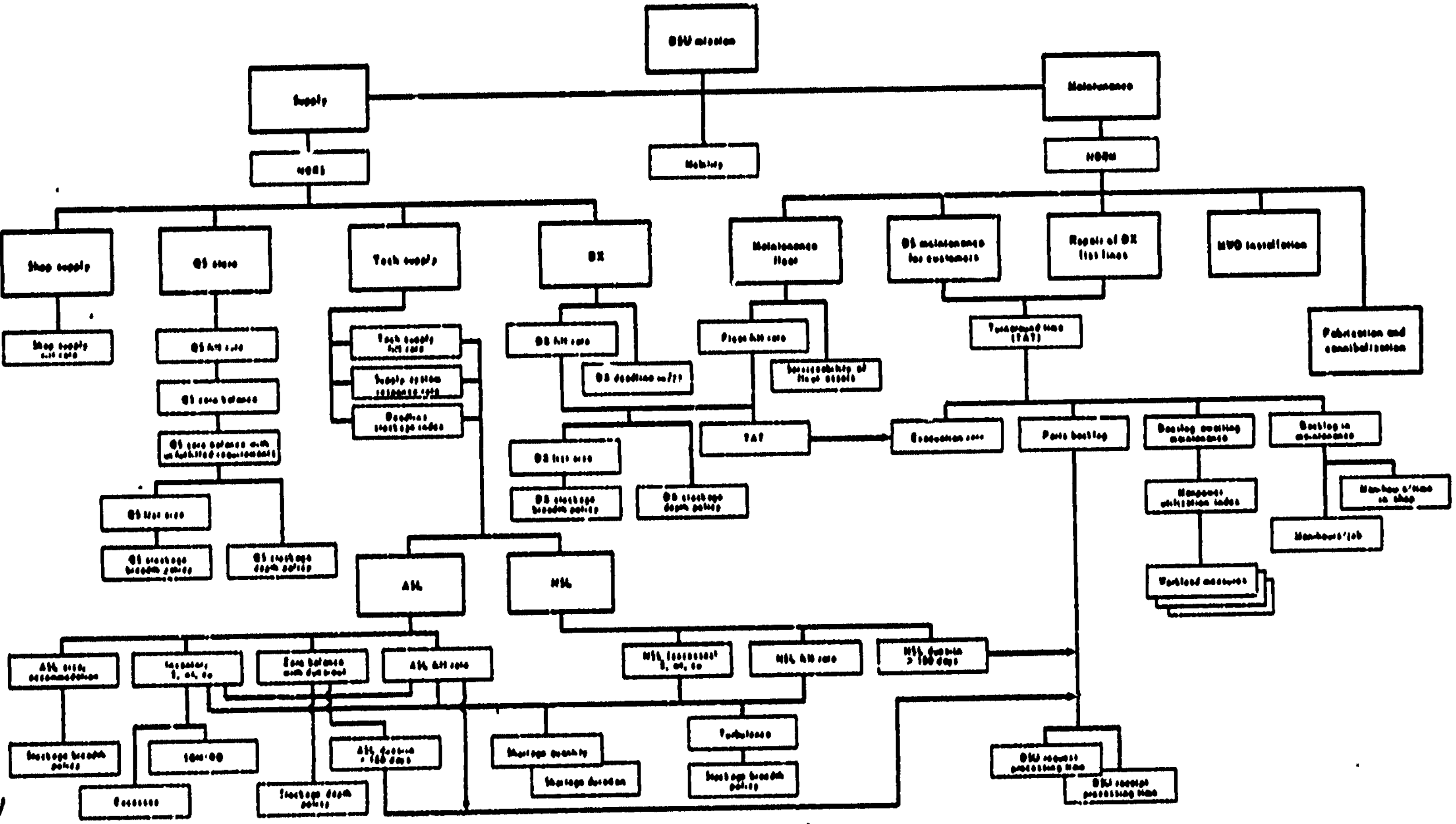

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Fig. 7—Hierarchy of DSU Functions and Performance Measures

Chapter 3

DSU SUPPLY PERFORMANCE—

MAJOR POLICY-RELATED MEASURES AND OBJECTIVES

GENERAL

Supply policies are the rules, procedures, and guidelines that are used in requesting, receiving, storing, issuing, and accounting for supplies and equipment. Accordingly, supply policy encompasses stockage policies—i.e., "what is to be stocked?" and "in what depth to stock?"; rules governing who may requisition from which echelons; assignment of priorities; inventory management techniques, etc. Of major concern in this discussion is the effect of stockage policy on the accomplishment of a DSU's supply mission as discussed in Chap. 2, and the measures of performance that quantify how well the DSU is doing its job.

Stockage policy at the DSU is set largely by DA; major commanders (theater or division) are given authorization to vary certain policies as their situations dictate, and within constraints set by DA. For example, maintenance battalions (divisional and nondivisional) may stock a maximum of 7500 lines and are authorized to alter stockage criteria so long as that maximum is not exceeded.[8]

It has been found that stockage policy indeed influences the performance of a DSU. Thus, regardless of the level of performance that may be desirable (or that may be demanded by higher headquarters), its achievement may be difficult or even impossible owing to the constraints imposed by the policies themselves. Recognition of implied or explicit limitations imposed by a particular policy is essential to the selection of meaningful and attainable objectives so as to permit effective measurement of DSU supply performance. The effects of breadth, depth, and QS policies on various measures of supply performance are discussed in this chapter.

PERFORMANCE VARIATIONS AS AFFECTED BY STOCKAGE BREADTH POLICY

The term "stockage breadth" refers to the number of different lines (FSNs) stocked at a supply point (ASL size). Stockage of the bulk of items on the ASL of a DSU is based on the number of demands registered for them during a previous time period, usually 12 months. Lines that are stocked according to this rule are termed "demand-supported." Other lines that add to the breadth of stockage at the DSU include standby and initial issue lines. The analyses presented in this chapter are based on lines that are demand-supported.

Of the several types of supply support operations performed by the DSU (DX, shop supply, and tech supply) that of tech supply is the one for which performance is most quoted. As discussed in Chap. 2, the tech supply function includes all those operations required to obtain, account for, store, and issue the repair parts, other maintenance supplies, and operational readiness float lines needed by supported units and the maintenance shops of the battalion. The primary breadth policy within tech supply (and the other supply operations as well) is termed "stockage criteria," or "addition-retention criteria." Present stockage criteria for the DSU tech supply function are 6-3, i.e., six demands are required for a line to be added to the ASL and at least three demands are required for its retention—each based on the most recent 12 months of demand history. Although not immediately evident, it will be shown that as addition and/or retention criteria are relaxed (i.e., reduced quantitatively), breadth of stockage (i.e., <u>ASL size</u>) will increase. Alternatively, as addition-retention criteria are made more stringent (increased quantitatively) breadth of stockage will be reduced. Therefore the breadth policy selected is a direct determinant of ASL size. Figures 8 to 10 portray the relation between breadth policy and ASL size for the tech supply operations of 3 divisions. These figures were derived from runs of the SCM[18,19] described in Chap. 1. Table 7 summarizes the data inputs used in the model runs.

Table 7

SUMMARY OF MODEL INPUT DATA

Division	Annual demand statistics		
	FSNs	Demands	Qty demanded
A	19,859	113,274	585,461
B	34,344	293,698	1,568,296
C	16,032	102,671	516,913

These data represent FSNs remaining after a computer editing based on the Army Master Data File (AMDF). A major aspect of this editing excludes lines not matching the AMDF and adds information for those lines that match the AMDF. A detailed discussion of the editing procedure used is contained in RAC-TP-435.[18] Detailed demand patterns for the divisions are contained in App B, Table B1.

Demand Accommodation: A Function of ASL Size

Reference to Fig. 7, Hierarchy of DSU Functions and Performance Measures, shows breadth policy as determining not only ASL size, but the measure "demand accommodation" as well. Demand accommodation is the percentage of total valid demands that match the ASL and is expressed in formula as:

$$\frac{\text{Valid ASL demands}}{\text{Total valid demands}} (100) = \%\text{ demand accommodations}$$

[Valid demands equal total demands less rejected demands. Rejection may result from a decision by the supplier that supply action cannot be taken owing to a specific cause indicated by a rejection code. Authorized rejection codes may be found in AR 725-50[20] but may also include locally assigned codes. Requests/requisitions are not supposed to be rejected (1) because the supplier is at zero balance or (2) in order to otherwise improve the supplier's performance rating.]

QS lines are excluded from the computation since detailed accountability is not required by QS procedures,[13] and customer demands for such lines would not be reflected in stock accounting records (manual or automated).

Figures 8 to 10 clearly show demand accommodation to be a function of stockage list size. See Fig. 8 for model results for division A,

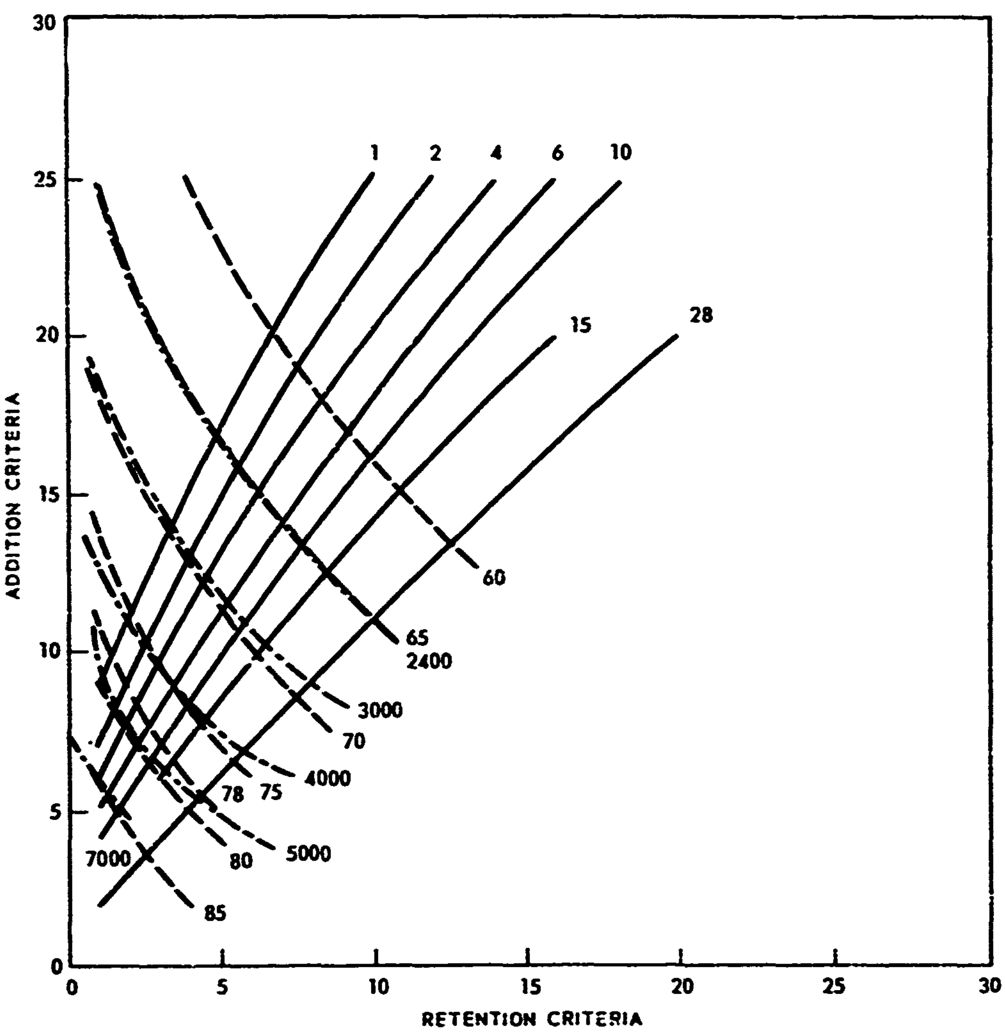

Fig. 8—SCM Results, Division A; Combines All Materiel Categories

—— % turbulence — — — % demand accommodation

—·— Stockage list size, lines

RAC

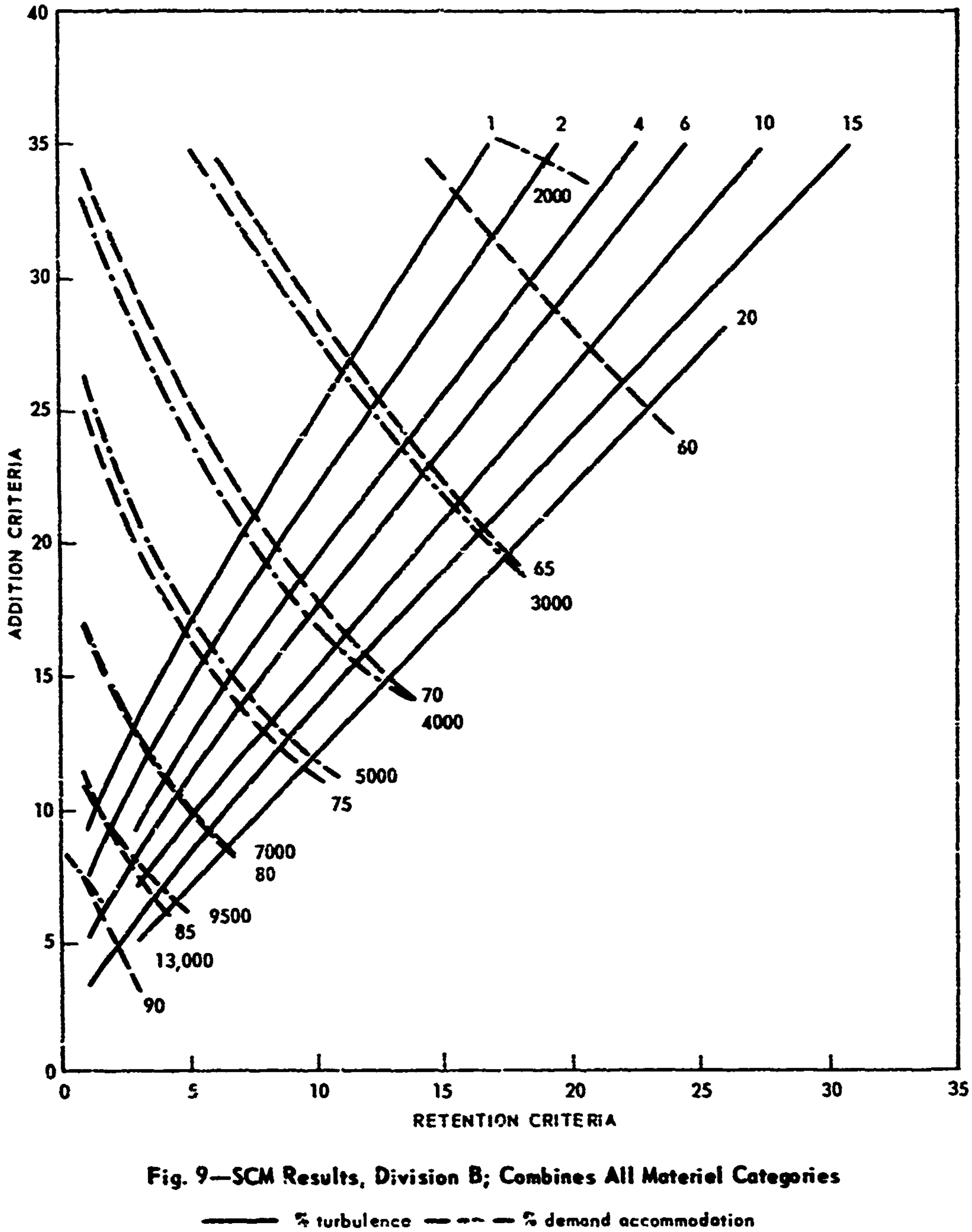

Fig. 9—SCM Results, Division B; Combines All Materiel Categories

——— % turbulence — — — % demand accommodation

—·— Stockage list size, lines

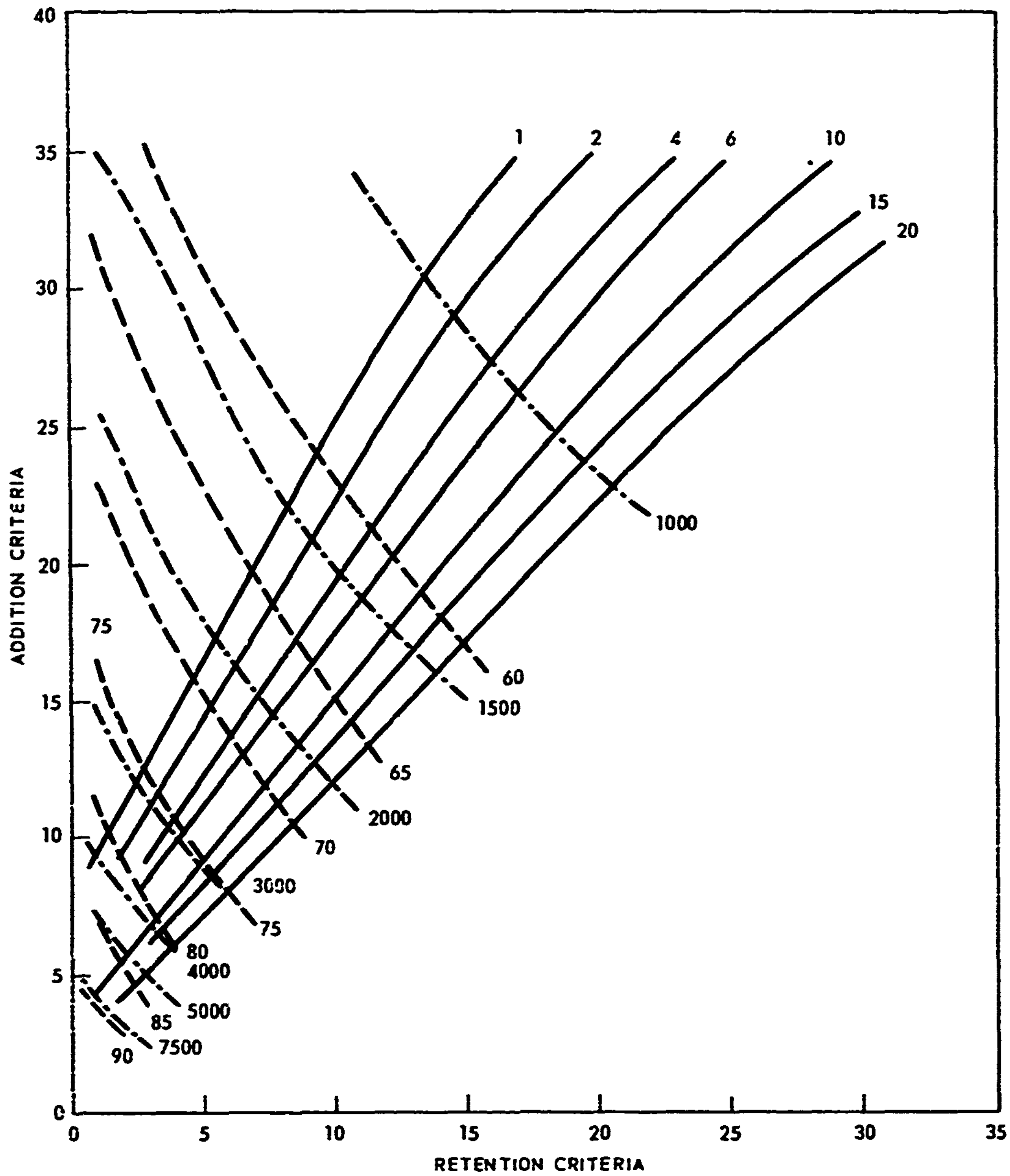

Fig. 10—SCM Results, Division C; Combines All Materiel Categories

——— % turbulence — — — % demand accommodation

—·—· Stockage list size, lines

where an ASL of 4000 lines yields demand accommodation of approximately 75 percent. By increasing the stockage list size to 5000 lines, demand accommodation climbs to nearly 80 percent. Each ASL size is seen to dictate a level of demand accommodation. Therefore selection of a breadth policy (addition-retention criteria) clearly predetermines not only ASL size but demand accommodation as well.*

Effect of ASL Size on Tech Supply Fill Rate. Stockage policy directly influences ASL size and demand accommodation, which, in turn, affects the primary performance measure, tech supply fill rate. Tech supply fill rate, as defined in Chap. 2, is the fraction of total valid demands for stocked and nonstocked lines for which fill is received on request:

$$\frac{\text{Valid demands completely filled}}{\text{Total valid demands}}(100) = \%\text{ tech supply fill rate}$$

(Valid demands equal total demands less rejects.) Demands for QS lines and for DX lines are excluded from the computation. Demands receiving partial fill are excluded from the numerator but specifically included in the denominator. This treatment of partial fills recognizes that a complete fill of a demand is required for the DSU to receive credit for having satisfied a customer. This measure combines the characteristics of two current Army performance measures: demand accommodation and demand satisfaction. Tech supply fill rate may also be derived by obtaining the product of these measures (demand accommodation times demand satisfaction), but only if it is assumed that no fill has been obtained from NSL assets.

Figure 11 relates tech supply fill rate to ASL size for 2 divisions. The data points shown plot the size-to-fill rate relation for 23 different breadth policies—the results of as many SPSM runs—each using the same stockage depth policy.** The points for the present

*Also, stockage list turbulence is determined by policy. This subject is discussed more fully in the next section.

**All SPSM runs that were made to address the problem of "breadth policy" used the Army's present operating level depth policy, i.e., $7\sqrt{\frac{Q}{P}}$ (see discussion of stockage depth).

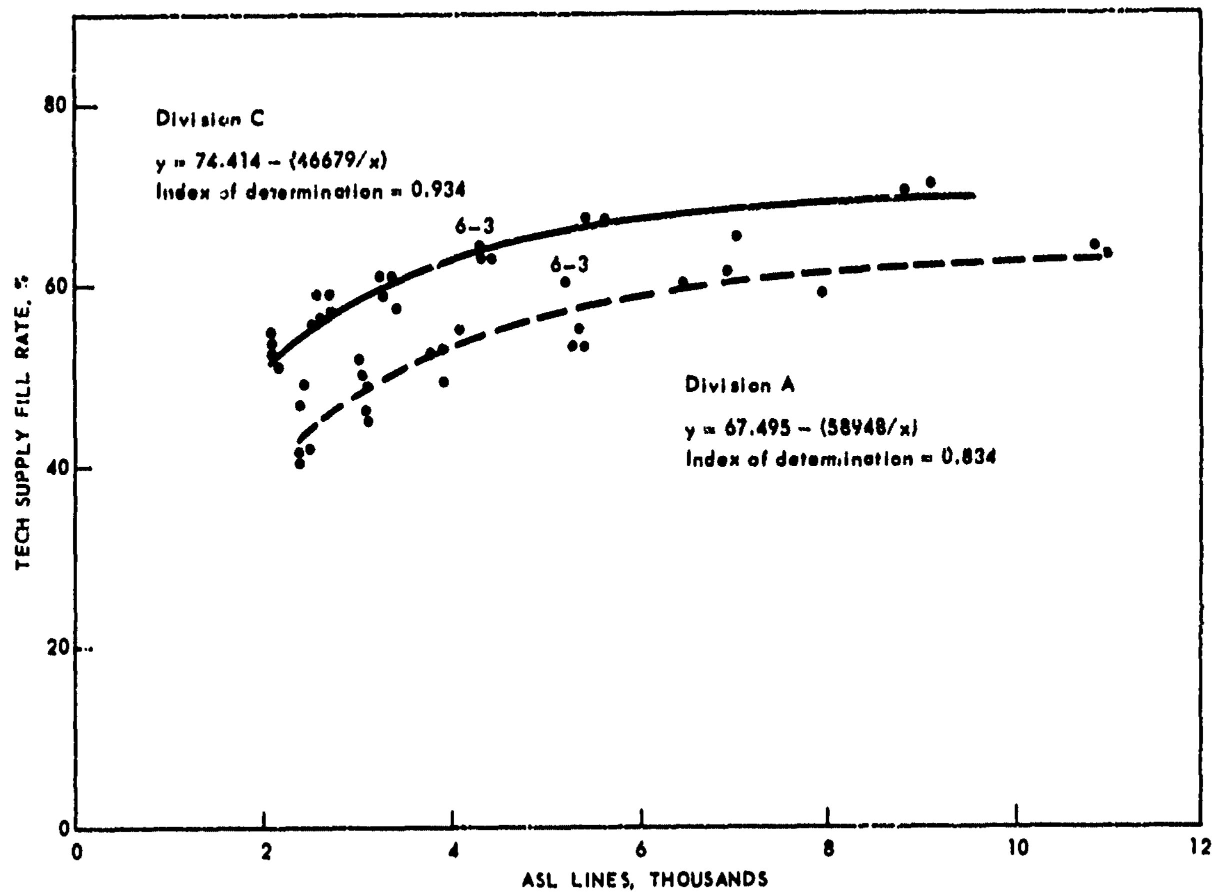

Fig. 11—Relation of Tech Supply Fill Rate to ASL Size

policy (6-3 addition-retention criteria) are indicated. Detailed results of model runs may be found in App B, Tables B4 and B5. Both curves show a fill rate plateau reached at about 5000 lines, above which an increase in ASL size does not result in an appreciable increase in fill rate. Indeed, the marginal values of Table 8 indicate that a similar argument could be made for ASL sizes for as few as 4000 lines.

Table 8

MARGINAL RELATION BETWEEN FILL RATE AND ASL SIZE

ASL size	Division A				Division C			
	Fill rate, %		Percent of increase in		Fill rate, %		Percent of increase in	
	Mean	Conf limits (95%)	ASL size	Fill rate	Mean	Conf limits (95%)	ASL size	Fill rate
2000	38	29-47	--	--	51	46-56	--	--
3000	48	40-55	50	26	59	55-63	50	16
4000	53	46-59	33	10	63	59-66	33	7
5000	56	50-61	25	6	65	62-68	25	3
6000	58	52-63	20	4	67	64-69	20	3
7000	59	54-64	17	2	68	65-70	17	1
8000	60	55-65	14	2	69	66-71	14	1

Thus the marginal increase in tech supply fill rate owing to increased stockage list size is much greater for ASLs in the 4000 to 6000 line range, than in the 6000+ range. The selection of a breadth policy that yields an ASL size in the 4000 to 6000 line range takes into account the change in slope evident in Fig. 11. The present 6-3 addition-retention policy yields ASLs within such a range for both divisions A and C. An objective of 64 percent for tech supply fill rate would be in keeping with ASLs in the 4000 to 6000 line range.

ASL Turbulence

ASL turbulence is defined as the amount of fluctuation in the different lines comprising an ASL (the sum of the additions and deletions experienced in a time period) expressed as a percentage of ASL size.

$$\frac{\text{Additions + deletions}}{\text{ASL size (avg)}} (100) = \% \text{ turbulence}$$

The same rules that determine stockage list size and demand accommodation influence the magnitude of turbulence experienced by an ASL. Figures 8 to 10 clearly illustrate this effect. It may be noted from these figures that the lines of constant turbulence indicate a nearly linear relation of addition and retention to turbulence. It may be inferred from this that when the difference between the addition criterion and the retention criterion remains constant, turbulence remains virtually constant. Also the smaller the difference between addition and retention criteria, the greater the turbulence experienced.

Other policy factors that affect ASL turbulence are (a) the time span of the demand data base — the control period — and (b) the frequency of review of the data base — the review interval. Analyses performed on these contributors to ASL turbulence[21] indicate that less frequent review of demand history results in less ASL turbulence. Also, a shortening of control period length is shown to result in increased ASL turbulence.*

Thus it is apparent that stockage list turbulence is controllable through modifications of the stockage policy parameters: addition-retention criteria, control period, and review interval.

Effect of Turbulence on Tech Supply Fill Rate. The reason for adding or deleting items from an ASL is ostensibly to make the ASL more responsive to the demands of its customers, while not letting inventory size and cost become excessive. In order to test this hypothesis, SCM and SPSM runs were made for a wide range of ASL sizes; stockage levels were set according to the Army's present policy. Utilizing linear multiple regression analysis,[22] it was possible to determine the relative contribution of various performance measures — including turbulence — to the higher level measure, tech supply fill rate. Table 9 summarizes the results of the multiple regression run.

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*The authors feel that the control period should be not less than 12 months and the review interval not less than 6 months.

Table 9

CONTRIBUTION OF VARIOUS PERFORMANCE MEASURES TO TECH SUPPLY FILL RATE

Variable	Regression coefficient[a]	Mean	Std dev, σ
Fill rate, percent (y)	38.9	60.0	5.86
ASL turbulence, percent (x_1)	-0.003	10.0	15.1
Demand accommodation, percent (x_2)	0.464	78.1	7.29
Zero balance with dues-out, percent (x_3)	-2.72	5.60	0.949

[a]Regression equation: $y_c = 38.9 - 0.003\ x_1 + 0.464\ x_2 - 2.72\ x_3$; degrees of freedom: numerator = 3, denominator = 19. Index of determination = 0.975; F - ratio test statistic = 244.

The subscript c in the regression equation denotes computed (rather than observed) values of the dependent variable y. The high index of determination indicates that 97.5 percent of the variation of fill rate about the regression line is explained by the variation in the three independent variables. The F ratio test statistic may be evaluated by referring to F tables in a statistics text.[23] The relation is statistically significant.

The regression equation may be used to evaluate the effects on the dependent variable of a unit increase in each independent variable while holding the other independent variables constant. For instance, a 1 percentage point increase in x_2 (demand accommodation), holding ASL turbulence and zero balance with dues-out constant, yields an increase in tech supply fill rate of 0.464 of a percentage point.

The effect of a 1 percentage point increase in ASL turbulence, holding demand accommodation and zero balance constant, results in only 0.003 of a percentage point increase in fill rate.

It may be concluded from the above analysis that ASL turbulence is a minor contributor to fill rate and that frequent additions to or deletions from the ASL do not, in themselves, improve the DSU's fill rate. The same conclusion might be reached intuitively by considering that most lines contributing to list turbulence are those of less frequently demanded classes[18] and hence could not greatly influence the fill given by a DSU.

An Objective for ASL Turbulence

The foregoing discussion indicates that (a) turbulence may be controlled by appropriate stockage policy decisions and (b) increasing turbulence does not appreciably improve tech supply fill rate. An additional and rarely discussed fact is that high turbulence imposes a workload on a DSU and inhibits good management. The workload derives from the additional bookkeeping required and the requirement to dispose of excesses.[8,24] In automated units the clerical workload associated with the addition or deletion of items is probably minimal. For manual operations, however, high turbulence r·· ·es could impose monumental clerical logjams. In addition, faced with an ever-changing stockage list, DSU personnel cannot be expected to know their stock, a prime requisite for effectively managing inventories of materiel.*

*GEN Frank S. Besson (USA-Ret), formerly Commander, US Army Materiel Command, and currently a consultant to RAC, has stated the following with regard to high turbulence at the DSU: "Turbulence in the range of 20 percent per year will result in such instability of the data base that managers will continue to be unable to understand and cope with supply management problems. Stockage criteria providing the same...demand accommodation...can be selected which will result in inconsequential turbulence.

"In the interest of minimizing record-keeping at the DSU level and reducing the data base perturbations that plague supply management... turbulence (should be kept) at less than 1 percent annually...

"Of vital significance (is) that there is no price to pay for reduced turbulence."[25]

In view of the detrimental effects of turbulence coupled with its negligible influence on tech supply fill rate, why have turbulence if it is within the capability of policymakers to control it? Accordingly an objective that greatly reduces ASL turbulence, perhaps to as little as 1 percent, would seem appropriate.

Table 10 presents statistics obtained from SCM runs for 3 divisions. The use of 6-3 criteria, present Army policy, is shown to yield ASL turbulence of 14 to 15 percent computed on an annual basis. This presumes the use of a 12 month control period and a review interval of 12 months.*

Proposed addition-retention criteria of 9-1 result in ASL size and demand accommodation nearly identical to that of the 6-3 criteria but with turbulence being cut to 1 percent. Simulations run using the SPSM result in little change in estimated NORS as a result of implementing the proposed policy (see App B, Tables B4 and B5.)

Table 10

SELECTED PERFORMANCE CHARACTERISTICS FOR
TWO STOCKAGE CRITERIA POLICIES

Performance characteristic	Division A		Division B		Division C	
	Addition-retention criteria					
	6-3	9-1	6-3	9-1	6-3	9-1
ASL size, no. of FSNs	5280	5300	10,900	10,960	4380	4390
Demand accommodation, %	80	81	87	87	82	83
ASL turbulence, annual %	15	1	14	1	14	1
Estimated NORS, %	5.7	5.4	--[a]	--[a]	5.0	5.1

[a]SPSM runs were not made for division B, hence estimated NORS is not available.

ASL and NSL Fill Rate

Contributing directly to tech supply fill rate are the performance measures, ASL and NSL fill rates. Indeed, the numerator of tech supply fill rate is the weighted average of ASL and NSL fill. The former, ASL fill rate, is more familiar to Army logisticians as demand satisfaction.

*More frequent review only slightly increases turbulence for the 9-1 criteria (Table 9). However, for the 6-3 criteria, review frequency has a great effect.[21]

ASL fill rate is defined as the percentage of valid ASL demands completely filled on request. The formula is:

$$\frac{\text{Valid ASL demands completely filled}}{\text{Total valid ASL demands}} (100) = \text{ASL fill rate, \%}$$

Valid demands equal total demands less rejects. Demands that can be only partially filled are to be counted as valid demands in the denominator but omitted from the numerator. ASL fill rate is not computed for QS lines or DX lines. The decision to exclude partial fills in the numerator was based on results of SPSM runs that indicated little difference between demand fills (complete fills) and quantity fills, which include partial fills (see App B, Tables B4 and B5). The difference is usually less than 2 percent, and quantity fill rate is frequently less than demand fill rate. Also the present Armywide practice for computing ASL fill rate (demand satisfaction) excludes partial fills.

An objective for ASL fill rate must be congruous with the demand accommodation and tech supply fill rate objectives discussed previously. ASL fill rate is unfortunately not a direct output of the SPSM; it may however, be derived from demand accommodation and tech supply fill rate statistics, which are direct outputs of the model. Such a derivation requires an assessment of NSL fill and its effect on tech supply fill rate.

Influence of NSL Fill on Tech Supply Fill Rate. Tech supply fill rate is a measure of the immediate fill given the customers of a DSU and is to include not only fill given for lines stocked on the ASL but fill given for lines that have fallen from the ASL to an NSL position and for which assets are still on hand. NSL fill rate may be defined by:

$$\frac{\text{NSL demands completely filled}}{\text{Total NSL demands}} (100) = \text{NSL fill rate, \%}$$

No requirement apparently exists for a DSU to report fill given from NSL assets; hence no empirical data are available on NSL fill rate. Field observation of DSU operations suggests that little fill is given from NSL assets and that therefore the overall tech supply fill rate is not appreciably improved by NSL fill. With the exception of model results that automatically combine ASL and NSL fill to arrive at the tech supply fill rate, the empirical results shown in this chapter

assume zero fill from NSL assets. To the extent that some fill is indeed given from NSL assets, the tech supply fill rates are slightly understated. The extent of this understatement, however, is not great, as evidenced by Tables 11 and 12.

Table 11 shows annual demand statistics for the HQ and A Co of the maintenance battalion for Division C. Of 164,609 requests received from customer units, 133,594 or 81 percent were for lines contained on the ASL. Of those 133,594 demands accommodated by the ASL 79,954 or 60 percent experienced immediate fill. Requests for NSL lines numbered 31,015. Although it is unknown just what fill was given for NSL requests, the impact of various hypothetical levels of NSL fill on the overall tech supply fill rate is shown in Table 12.

Table 11

ANNUAL DEMAND STATISTICS FOR DIVISION C

Item		Amount
Requests received		184,843
Requests rejected	20,234	
Net requests		164,609
Requests accommodated (ASL)		133,594 (81%)
ASL requests filled		79,954 (60%)
Requests not accommodated (NSL)		31,015 (19%)

Thus, if no fill is obtained from NSL assets, the tech supply fill rate is based solely on ASL fill and is derived by: $\frac{79,954}{164,609}$ (100) = 49 percent.

If 5 percent of the 31,015 NSL requests are filled, the effect on tech supply fill rate is an increase of 1 percentage point $\frac{81,505}{164,609}$ (100) = 50 percent. If 30 percent of NSL requests are filled, the tech supply fill rate climbs to only 54 percent. Since fill of ASL requests is only 60 percent, it would be extremely unlikely that NSL fill would be even one-half as much (30 percent). Therefore the influence on tech supply fill rate of NSL fill is seen to be minimal.

Table 12

IMPACT OF VARIOUS NSL FILL LEVELS
ON TECH SUPPLY FILL RATE

Item	Percent of NSL requests filled						
	0	5	10	15	20	25	30
Number NSL requests filled	0	1,551	3,102	4,652	6,204	7,754	9,305
Total requests filled	79,954	81,505	83,056	84,606	86,158	87,708	89,259
Tech supply fill rate, %	49	50	50	51	52	53	54

An Objective for ASL Fill Rate. The model output statistic, tech supply fill rate includes unknown amounts of ASL and NSL fill. By hypothesizing various levels of NSL fill and using model outputs for tech supply fill rate and demand accommodation, it is possible to derive an ASL fill rate commensurate with its related measures. Lines 1 and 2 of Table 13 show model outputs for tech supply fill rate and

Table 13

DEVELOPMENT OF ASL FILL RATE OBJECTIVES
BASED ON HYPOTHETICAL NSL FILL RATE ESTIMATES

Item	6-3 policy		9-1 policy	
	Division A	Division C	Division A	Division C
NSL fill rate equals 0%				
1. Tech supply fill rate, %	57	64	55	63
2. Demand accommodation, %	80	82	81	83
3. ASL fill rate (line 1/line 2), %	71	78	67	76
NSL fill rate equals 30%				
4. Tech supply fill rate, % (line 1 minus 5 percentage points)	52	59	50	58
5. ASL fill rate (line 4/line 2), %	65	71	61	70

demand accommodation for 6-3 and 9-1 addition-retention criteria, respectively. Line 3 shows the computation of ASL fill rate assuming zero fill from NSL assets. This discussion utilizes a previous definition of tech supply fill rate--the product of demand accommodation and ASL fill rate, assuming zero fill from NSL assets.

Table 12 shows that if NSL fill amounts to as much as 30 percent, the increase in tech supply fill rate is a nominal 5 percentage points over tech supply fill rate with zero NSL fill (49 to 54 percent). To arrive at the ASL fill rate contribution to tech supply fill rate, assuming a 30 percent NSL fill rate, line 4 Table 13, degrades the line 1 figure by 5 percentage points, the NSL fill contribution to the tech supply fill rate . Line 5 shows the ASL fill rates resulting from the 30 percent NSL fill rate assumption.

Figure 12 illustrates the development of ASL fill rate using division C values (6-3 policy) from Table 13. The figure is based on 1000 valid demands received at the DSU and uses model outputs of 64 percent for tech supply fill rate and 82 percent for demand accommodation. Tech supply fill rate is graphically shown to have two components--ASL fill and NSL fill. Figure 12a assumes an NSL fill rate of zero percent that is seen to result in an ASL fill rate of 78 percent. Figure 12b assumes an NSL fill rate of 30 percent that results in an ASL fill rate of 71 percent. The product, ASL fill rate times ASL demands, yields the number of ASL fills .

Based on the foregoing discussion and recognizing that not more than a 30 percent NSL fill rate is likely to occur (and probably considerably less than that amount), a conservative objective of 71 percent* is advanced for the 6-3 policy and 70 percent* for the 9-1 policy.

Zero Balance with Dues-Out

The multiple regression analysis discussed in Table 9 relates three independent variables to the dependent variable, tech supply fill rate. Of the three independent variables, zero balance with

*Fill rates exhibited by division C are used because it is felt that other divisions can achieve these rates. Assuming no NSL fill, division A almost achieves them.

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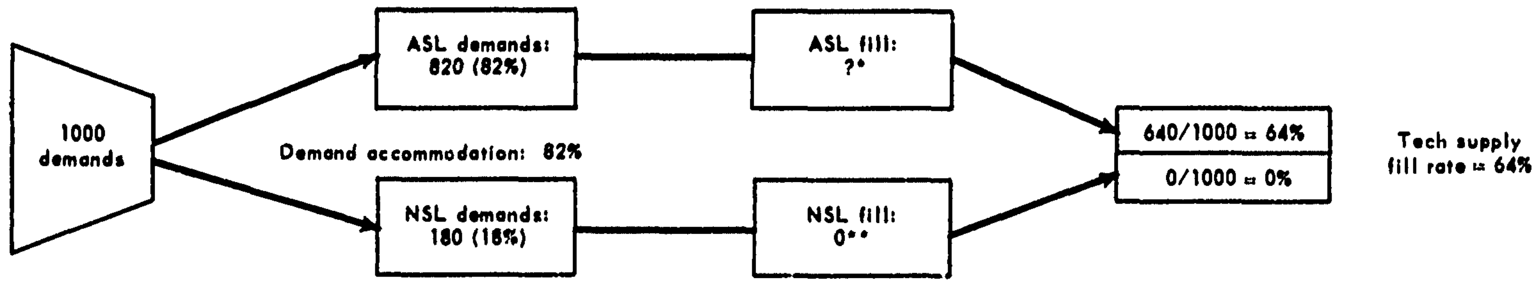
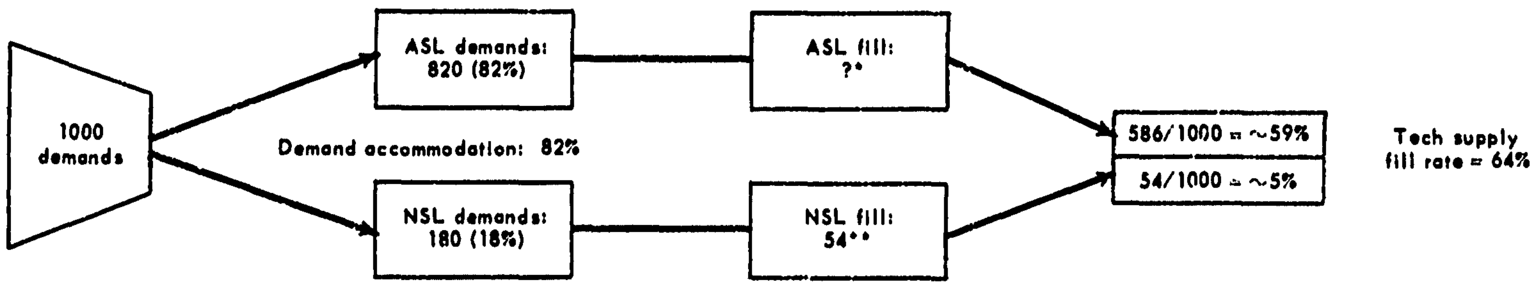


a. NSL Fill Rate = 0%

*ASL fill rate = tech supply fill rate/demand accommodation
= 0.64/0.82 = 0.78 or 78%

**NSL fill = 0 × 180 = 0



b. NSL Fill Rate = 30%

*ASL fill rate = tech supply fill rate/demand accommodation
= 0.59/0.82 = 0.71 or 71%

**NSL fill = 0.30 × 180 = 54

Fig. 12—Development of an ASL Fill Rate Objective for Division C

RAC

dues-out was noted to have the greatest influence on tech supply fill rate. The regression equation that described the relation indicated that for each 1 percent increase in zero balance with dues-out, a 2.72 percent de line in tech supply fill rate would occur.

The measure is defined as the fraction of ASL lines at zero balance for which dues-out are recorded. The formula is:

$$\frac{\text{ASL lines at zero balance with dues-out}}{\text{Total ASL lines}} (100) = \% \text{ zero balance with dues-out}$$

This measure does not necessarily reflect performance or operations of the DSU itself. Instead it could, given DSU adherence to ordering rules, be symptomatic of a condition within the system as a whole.

The source of data for developing this measure depends on computer availability. For automated operations, MIR or stock status reports prepared periodically by computer provide the necessary data. For manual operations a physical count of FSNs at zero balance with quantities owed to customers is required.

To develop an objective for this measure it is necessary to consider other measures that are directly relatable to the breadth policy in effect. It was noted previously that ASL size and tech supply fill rate were directly related and that beyond the ASL size of 6000 lines the marginal increase in fill rate was quite small in relation to the marginal increase in ASL size.

Fill rate may be related, in turn, to zero balances with dues-out. Such a relation is plotted in Fig. 13d, using results of SPSM runs based on division C data. Table 14 presents these relations for ASL sizes ranging from 4,000 to 6,000 lines.

Table 14

RELATION OF TECH SUPPLY FILL RATE TO
ZERO BALANCE WITH DUES-OUT

ASL size	Tech supply fill rate	Zero balance with dues-out
4000	63	5.0
5000	65	4.7
6000	67	4.5

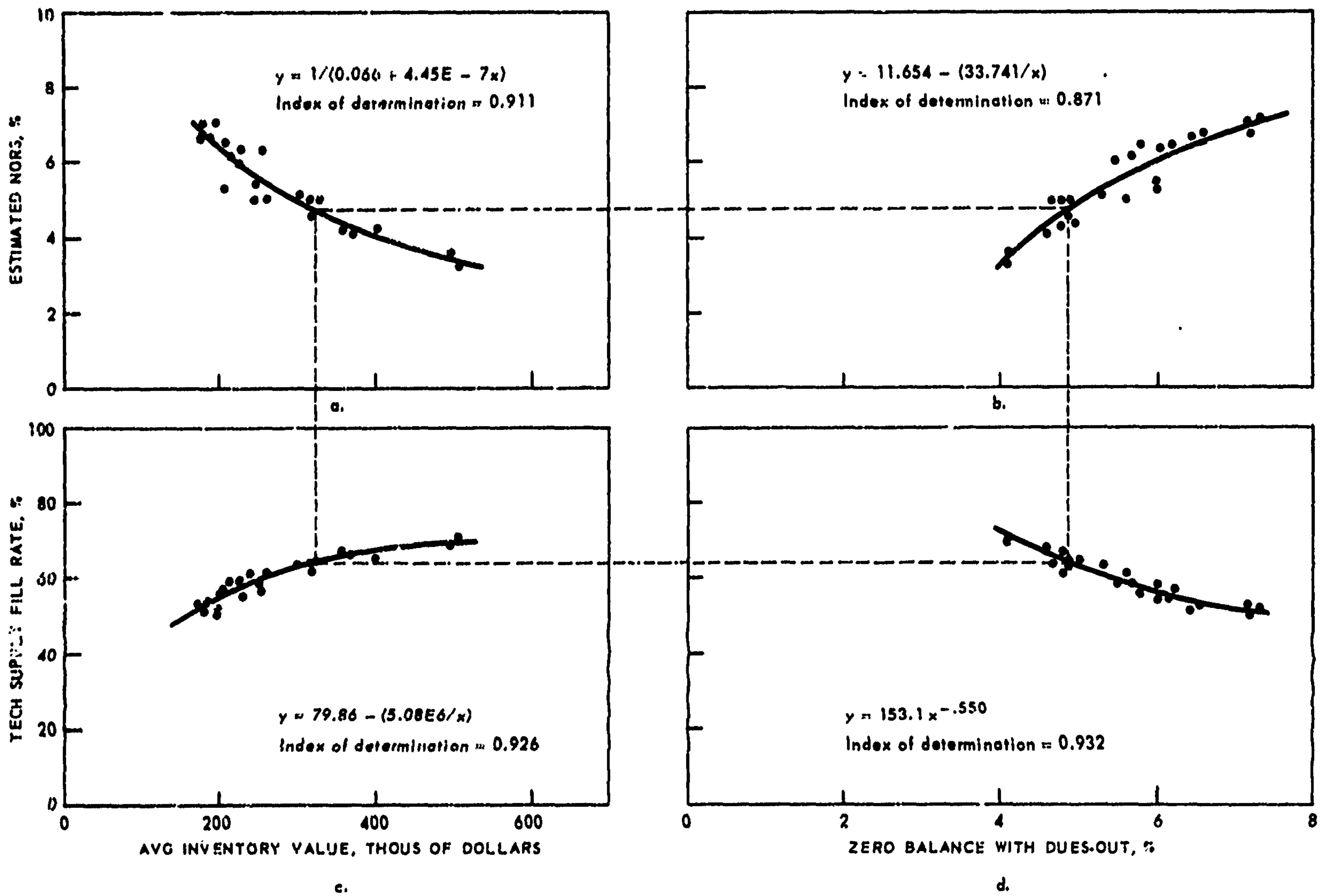


Fig. 13—Interrelations among Selected Performance Measures as Affected by Alternative Stockage Breadth Policies, Division C

Data points indicate results for a specific addition-retention criteria policy.

These values differ slightly from those obtained using division A data. Appendix Table B4 for the division A shows that the 6-3 addition-retention breadth policy yields 5000 ASL lines, a fill rate of 57 percent, and zero balance with dues-out of 6.7 percent. Based on these results from SPSM runs, an acceptable range for a zero balance with dues-out objective would be 4.7 to 6.7 percent.

Average Inventory Value

Average inventory value, as discussed in this section, refers to the dollar value of average inventory on hand at the DSU. This measure is but one of several possible ways to relate dollars to performance levels. Other ways include the use of pipeline investment or consideration of the various costs involved in holding and ordering inventory assets. The latter values have been developed from SPSM runs and are shown in appendix Tables B4 and B5.

Figure 13c relates average inventory value to tech supply fill rate for various breadth policies using division C data. As indicated, an average inventory value of $325,000 will result in a tech supply fill rate of 64 percent. These values result from use of a 6-3 addition-retention criteria. Desired increases in fill rate are seen to be possible to a certain point with increases in average inventory value. However, fill rate tends to level off at about 70 percent regardless of increased inventory value.

Although no objective is advanced for average inventory value, the relation between average inventory investment and fill rate is a real one, and should dollar constraints ever be imposed on DSU supply operations the resultant influence on tech supply fill rate and ultimately the NORS rate would need to be reassessed.

Breadth Policy and NORS

Figures 13a and 13b depict the respective relations of average inventory value and zero balances with dues-out to an estimated NORS rate, for 23 stockage breadth policies. The measure "estimated NORS" is calculated using a combination of SPSM output statistics and the results of the empirical and statistical analysis shown in Figs. 5 and 6. The following discussion shows the derivation of the NORS statistic.

A "NORS factor" is first derived for each stockage breadth policy

through the calculation

NORS factor = (1 - tech supply quantity fill rate) x avg shortage duration

See Table 15 for illustration using several breadth policies.

Column a in Table 15 portrays the fraction of the quantity demanded not receiving fill. A portion of these demands will doubtless be for lines that do not deadline equipment and hence will not affect NORS. That portion is assumed constant for each breadth policy and thereby influences all results equally. The fraction of items demanded not filled (col a) must await assets for a time equal to the average duration of a shortage (col b). The NORS factor is derived from the product of col a and b. This factor is assumed to e proportional to the NORS rate.

Table 15

DERIVATION OF ESTIMATED NORS RATES

Division C

Breadth policy (addition-retention criteria)	1 - Tech supply quantity fill rate, % (a)	Average duration of a shortage, days (b)	NORS factor (a x b) (c)	Estimated NORS rate (d)
6-3[a]	39.0	51	19.8	.050[b]
8-4	45.5	56	25.4	.064
2-2	29.1	45	13.2	.033
3-3	36.4	47	17.2	.043
5-4	37.6	49	18.2	.046
9-1	38.9	52	20.1	.051

[a]Present Army policy.

[b]$y = -0.051 + (0.064/x)$ where $x = 63.6$, as in SPSM output.

The NORS value for current Army breadth policy provides the basis for estimating NORS for alternative breadth policies. The regression equation describing the relation of tech supply fill rate to NORS (Fig. 6), was used to derive the NORS for the 6-3 case.

Using the present Army policy as the base, comparative NORS values may be readily derived for other stockage policies:

$$\text{Estimated NORS rate} = \text{NORS factor} \times \frac{0.050}{19.8}$$

As shown in Fig. 13a, average inventory value is inversely related to the NORS rate. Thus increases in average inventory investment result in decreased NORS, as might be expected. A high degree of relation is apparent here based on an index of determination of 0.911.

Figure 13b shows that zero balance with dues-out relates directly to the estimated NORS statistic, i.e., as zero balance with dues-out increases, NORS increases.

Recapitulation. The four graphs of Fig. 13 show, in concert, the interrelations among four important variables. From this figure it is also clear that policy decisions affecting the breadth of stockage have far-reaching effects, in that several performance measures are affected. While four measures are highlighted here, the effects on other measures are detailed in App B Tables B4 and B5. Such figures point out two important facts. First, the attainment of an objective established by fiat, without consideration of constraints inherent to the policy, may be patently impossible to achieve based on the stockage breadth policy in effect. For example, a NORS rate of 3 percent and the 6-3 addition-retention criteria policy depicted by the dashed lines in Fig. 13 are shown to be incompatible. Likewise, a tech supply fill rate of 80 percent is unachievable with any of the 23 policies considered. Second, the establishment of an objective for one performance measure may dictate the level of possible attainment for another measure. For example, an objective of 65 percent for tech supply fill rate dictates in turn a zero balance with dues-out of nearly 5 percent.

Summary of Breadth Analyses

The breadth analyses presented in this section are based on like stockage levels, namely, the sum of a 15 day safety level, a 45 day OST level, and an operating level which is based on the EOQ concept. A detailed discussion of EOQ is presented in a following section of the chapter. Accordingly, changes in the various measures are due

mainly to the addition or deletion of lines from the stockage list as a result of relaxing or tightening addition-retention criteria rules.

Table 16 summarizes the analyses presented in this section. Two breadth policies are highlighted, the 6-3 and the 9-1 addition-retention criteria, respectively. The 6-3 policy is the one currently in effect at DSU level in the Army. The 9-1 policy gives virtually the same performance as the 6-3 policy, based on model results, but with greatly reduced ASL turbulence.

Recent performance statistics for two divisions are also indicated. These are shown for the purpose of allowing a frame of reference against which to compare model results and proposed objectives.

A comparison of recent performance (mean) with model results shows the latter to result in more favorable statistics. For example, model zero balances with dues-out are less than one-half the amount being reported by each division. The more favorable model results are accounted for by the fact that the model represents ideal conditions, i.e., demands occur according to a mathematical distribution based on empirical data , lines are automatically added to or deleted from the ASL based on demand experience, ASL stocks are reordered instantaneously on reaching the reorder point, and no bookkeeping errors occur. Field observation and analysis of MIR for many DSUs indicate that such ideal conditions do not exist. To the extent that actual performance is less than the perfect model-generated performance, the differences noted in Table 16 are to be expected.

It should be noted that the model treats demand-supported lines only. Many lines carried on the ASL of DSUs are stocked for other reasons, e.g., mission essentiality, combat essentiality, and initial stockage in support of newly issued equipment. The contribution of such lines, if included in model results, although probably not appreciable, would tend to improve them slightly.

In arriving at suitable objectives for the measures shown, the model results for two divisions were the primary determinants. As may be seen, the model results for the divisions differ somewhat, a fact largely due to their different demand characteristics which were

Table 16

SUMMARY OF BREADTH ANALYSES AND RESULTING PERFORMANCE OBJECTIVES

Performance measure	Recent actual performance					6-3 breadth policy			9-1 breadth policy		
	Months of data available	Division A		Division C		Model results		Obj	Model results		Obj
		Mean	Range, monthly	Mean	Range, monthly	Div A	Div C		Div A	Div C	
Demand accommodation, %	11	73	65-89	82	71-92	80	82	82	81	83	83
ASL turbulence, annual, %	9[a]	98	-	153	-	15[b]	14[b]	14[b]	1[b]	1[b]	1[b]
ASL fill rate (demand satisfaction)	11	68	58-60	61	51-68	65[c]	71[c]	71[c]	61[c]	70[c]	70[c]
Zero balance with dues-out, %	9[d]	15	3-23	14	10-17	6.7	4.7	4.7	5.7	5.3	5.3
Tech supply fill rate,[e] %	11	50	41-65	50	35-53	57	64	64	55	63	63
NORS, %	12[d]	6.3	5.9-6.7 (quarterly)	7.0	5.9-7.7 (quarterly)	5.7	5.0	5.0	5.4	5.1	5.1

[a]RAC TP-453, "The Effects of Control Period and Review Interval on Selected Measures of Supply Performance."[21]

[b]Predicated on annual review interval and control period. Shorter review intervals and/or control periods will result in greater annual turbulence.

[c]Assumed 30 percent fill from NSL assets.

[d]Reference 26.

[e]Assumes zero fill from NSL assets.

reflected in the inputs to the model. In selecting a combined objective the better performance value yielded by the two divisions was used.

PERFORMANCE MEASURES AFFECTED BY STOCKAGE DEPTH POLICY

Stockage depth refers to the quantity of parts stocked for a particular stock number. It is measured either in quantity or in days of supply. The total stockage depth is the sum of the safety level (SL), the OST level, and the OL, and is called the RO.

An earlier RAC document[14] describes the supply performance that will result from variations in depth (in OST level) and in OST itself. This section considers variations in the OL and their effects on performance in order to arrive at reasonable estimates of and objectives for certain measures that are closely related to stockage depth. Analysis of the sensitivity of these measures to variations in OL quantity will familiarize the reader with the extent to which performance depends on the external constraints imposed by depth policy decisions. Performance, and therefore the quality of customer support, can be either the victim or the beneficiary of depth policy.

Naturally, certain constraints are necessary because funds are not unlimited. The result is imperfect performance. The best a supply manager can hope for is to minimize the adverse effects of policy-imposed limits on performance.

Stockage Depth Policies Considered

Several variations in stockage depth policy for division C were evaluated using the SPSM. The demand class information and the OST data for the simulations may be found in appendix Tables B2 and B6. The safety level for all "runs" was set at 15 days worth of demand quantity, and the OST portion of the stockage level was set at 45 days worth, in accordance with current practice in the DSS in Europe.[27] The OL quantity was computed using the Wilson Economic Order Quantity[28] (EOQ) formula, which is:

$$EOQ = \sqrt{\frac{2CQ}{HP}}$$

where C = cost to order
Q = anual demand quantity
H = holding cost factor (expressed as a fraction of the value of average assets on hand)
P = unit price of the line

The EOQ formula is used to minimize total variable cost. The total variable cost is the sum of the ordering cost (C x number of orders) and the holding cost (H x P x avg quantity on hand). This concept is illustrated in Fig. 14.[28]

In order to compute the EOQ for a line, an assumption must be made concerning the values for C and H. Currently, for those activities authorized to use the EOQ, the Army assumes that C = $10 per order, and that H = 0.40.

Substituting these values into the EOQ formula results in a simplified form used by the Army:

$$\text{EOQ} = 7\sqrt{\frac{Q}{P}}$$

The OL is then set equal to the EOQ for each line, unless $\text{EOQ} > \frac{Q}{3}$, in which case $\text{OL} = \frac{Q}{3}$ or $\frac{\text{EOQ}}{3}$, whichever is larger.[29] The value 7 in the above formula may be thought of as an "OL factor" and is simply a function of the C and H values assumed. Obviously, in order to reach the optimal (minimum) total variable cost described in Fig. 13, the selection of C and H must be realistic. The Air Force uses different values: C = $5; H = 0.50.[30] These values reduce to an OL factor of 4.4. An earlier RAC effort calculated that C = $3.20 and H = 0.68, based on the personnel, equipment, and interest (H only) expenditures of a mechanized infantry division.[31]

Based on the thesis that several different holding and ordering cost assumptions might be no less valid than those cited above, the combinations given in Table 17 were developed. For each, an OL factor was derived, and the resultant formula was used to compute the OL in the subsequent SPSM run. The combinations used were selected because they offered a range of values for H and C and a fairly wide range of values for the OL factor. The results of the simulations using the various OL factors in Table 17 are covered in the following sections. Each section is described in terms of the effects of variations in stockage depth policy on a particular measure of performance.

Effects of Stockage Depth on Tech Supply Fill Rate

Tech supply fill rate (defined in Chap. 2) is directly affected by variations in the stockage depth policy. Figure 15 illustrates

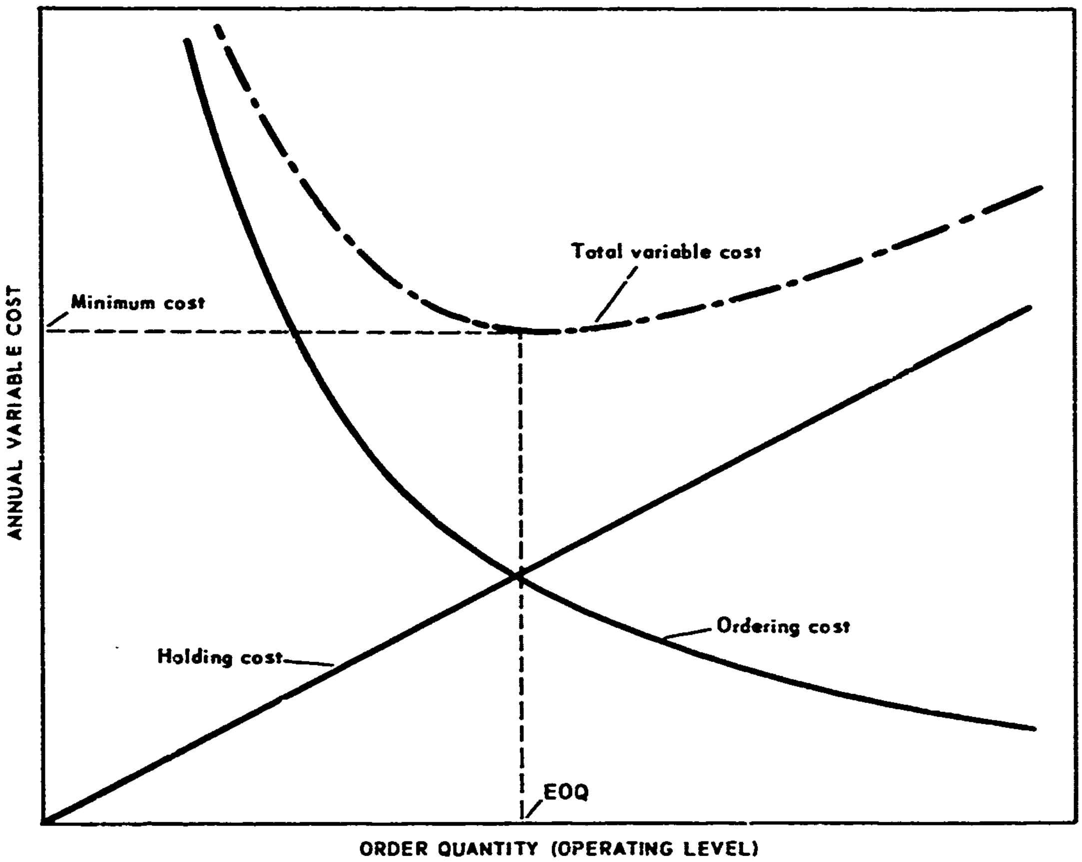


Fig. 14—Development of EOQ To Minimize Total Annual Variable Cost

Table 17

H AND C ASSUMPTIONS USED IN STOCKAGE DEPTH ANALYSIS

Assumption number	Holding cost factor, H	Ordering cost, dollars C	OL factor
1	.24	20.00	13
2	.40	3.20	4
3	.40	5.00	5
4[a]	.40	10.00	7
5	.40	20.00	10
6[b]	.50	5.00	4.4
7	.50	10.00	6.3
8	.50	18.00	8.5
9[c]	.68	3.20	3
10	.68	10.00	5.4
11[d]	None assumed		Fixed

[a]Current Army assumption.
[b]Current Air Force assumption.[30]
[c]Reference 31.
[d]Former Army policy.

the relation. As would be expected, increasing the OL increases the fill rate. The equation shown on the figure is the best fit regression equation for the actual tech supply fill rate values, which are shown as points. The high index of determination, 0.92, indicates a good fit of the actual y values (tech supply fill rate) to the expected values.

Figure 16 is a plot of the average inventory investment required to attain the various tech supply fill rates, superimposed on the curve from Fig. 15. Again, there is a close relation between the inventory investment and the stockage depth, as reflected in the OL factor. The rate of increase in required inventory investment as the OL factor is increased is greater than the rate of increase in tech supply fill rate. This fact is further illustrated by Table 18, in which the percentage increases are listed. As the increase in tech supply fill

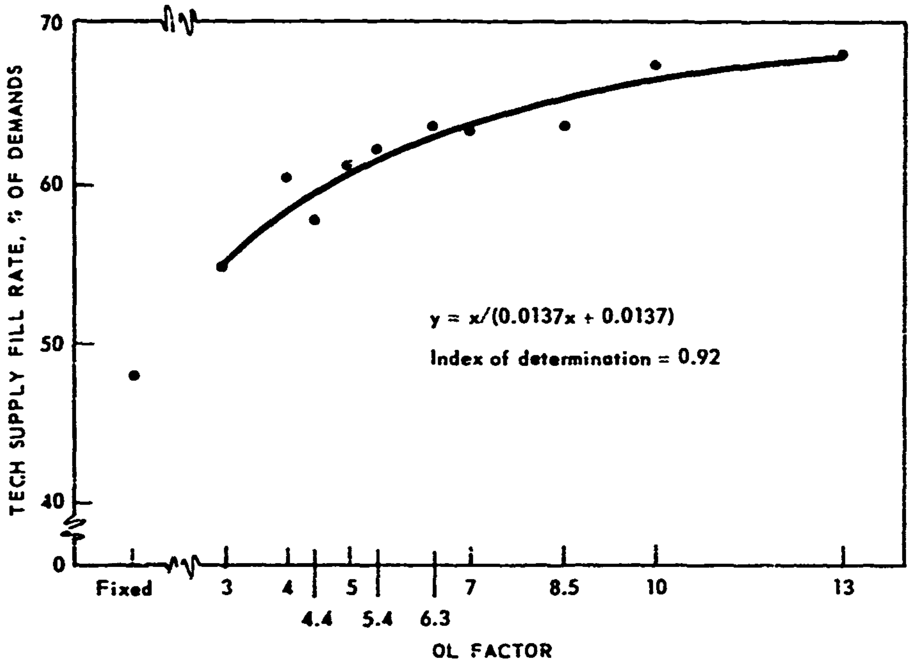


Fig. 15—Tech Supply Fill Rate as Affected by Variations in Stockage Depth

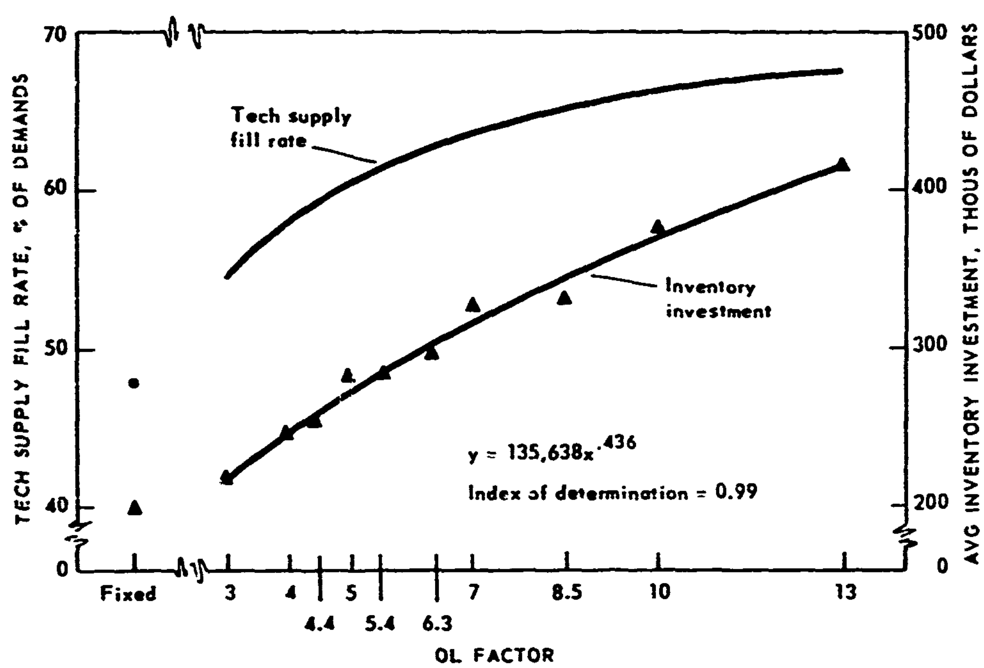


Fig. 16—Inventory Investment Required To Attain Differing Tech Supply Fill Rates via Variations in Stockage Depth

rate becomes marginal, the investment required continues to climb. Increasing the OL factor from 3 to 13 will raise the tech supply fill rate from 54.6 to 68.0 percent, an increase of 25 percent. However, that improvement would require an increase of almost $200,000 in average inventory investment for the DSU, or an increase of 91 percent.

Quantity Fill Rate. The results for quantity fill rate are plotted in Fig. 17. The curve is quite similar to that of Fig. 16: increasing the OL factor from 3 to 13 will improve quantity fill rate from 51.3 to 66.9 percent, a 30 percent increase.

NORS Rate and Stockage Depth - Are They Related?

As explained in Chap. 2, a direct relation has been established between NORS and tech supply fill rate. However, because rather large increases in depth result in relatively small increases in tech supply fill rate, little correlation was found between NORS and the variations in tech supply fill rate wrought by changing the stockage depth.* Indeed, when an attempt was made to relate the OL factor itself to NORS, the index of determination was only 0.41, which is considered no correlation. In addition, higher degree (polynomial) least squares fits were tried to no avail. The index of determination for the 3rd degree polynomial was only 0.42.

NORS as a function of OL factor is plotted in Fig. 18.

That the relation between stockage depth and NORS is tenuous should come as no surprise. It is logical to assume that greater depth of stockage will result in fewer zero balances. Thus, for the lines already on the ASL, NORS will occur somewhat less frequently. But the major means of reducing NORS would logically be to increase the breadth of stockage, as has been illustrated earlier in this chapter.

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*The 6 approximating functions for which correlation was tested[21] were:

$$y = a + bx \qquad y = \frac{1}{a + bx}$$

$$y = ae^{bx}$$

$$y = ax^{b} \qquad y = \frac{x}{a + bx}$$

$$y = a + \frac{b}{x}$$

The highest index of determination found was 0.38.

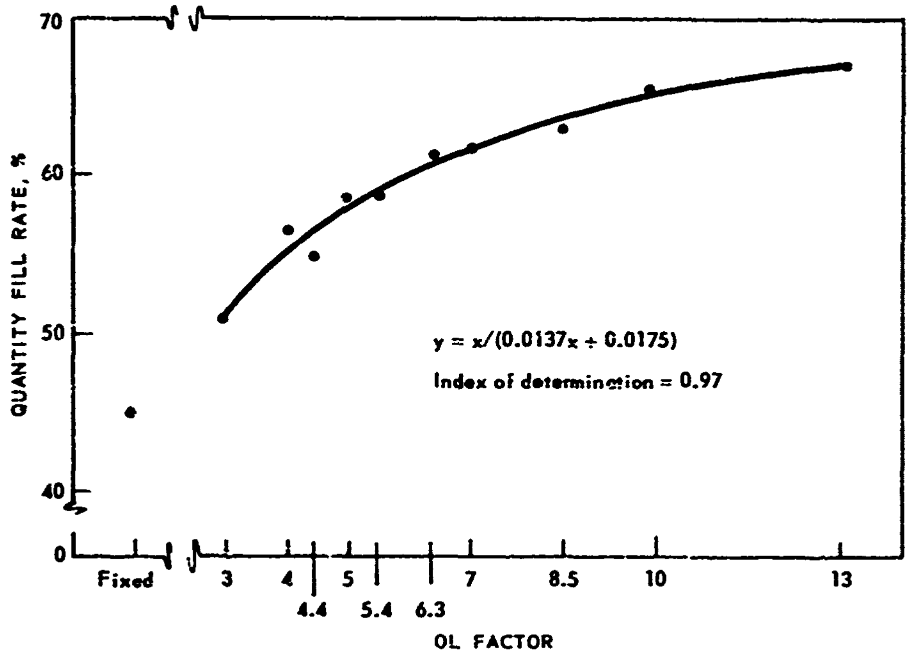

Fig. 17—Quantity Fill Rate as Affected by Stockage Depth Variations

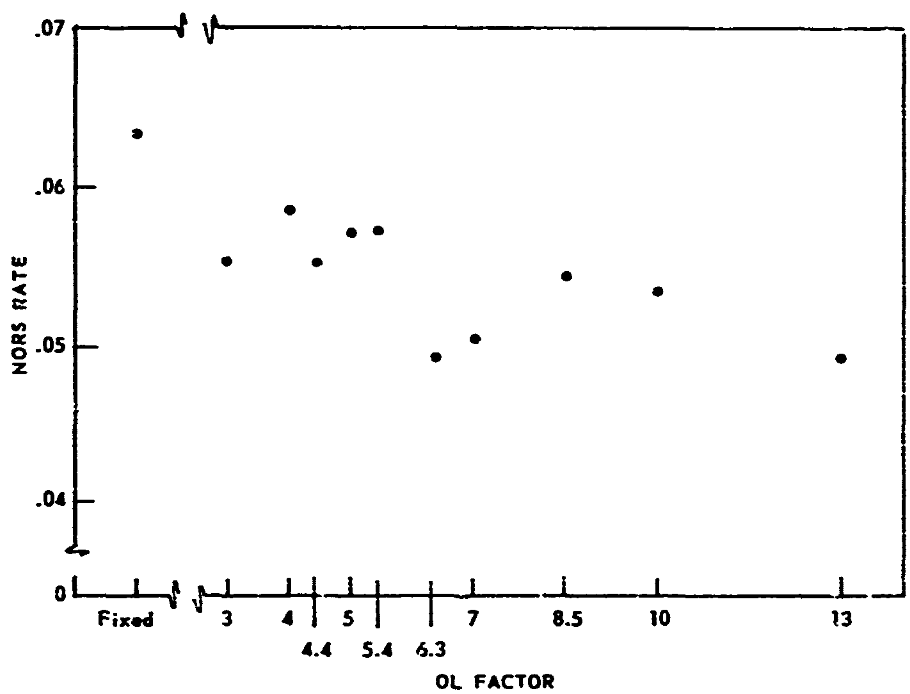

Fig. 18—Relation of NORS Rate to Variations in Stockage Depth

Table 18

TECH SUPPLY FILL RATE AND INVENTORY VALUE

AS AFFECTED BY STOCKAGE DEPTH

OL factor	Tech supply fill rate		Avg inventory investment	
	Percent	% increase	Dollars, thousands	% increase
3	54.6		219	
		11		13
4	60.4		247	
		4		4
4.4	57.7		257	
		6		9
5	61.6		281	
		2		1
5.4	62.1		283	
		3		5
6.3	63.7		298	
		0		9
7	63.6		325	
		0		2
8.5	63.8		330	
		6		14
10	67.8		375	
		0		11
13	68.0		418	

Parts Shortages and Their Duration - Effects of Deeper Stockage

Annual parts shortages are reduced by increasing the stockage depth, as illustrated in Fig. 19. In going from an OL factor of 3 to 13, the reduction in annual shortages amounts to about 68,000 parts, a reduction of approximately 28 percent. A DSU can expect annual shortages to run about 200,000 parts for an OL factor of 7.

Shortage duration, however, presents a different picture. In Fig. 20 the average duration of shortages is plotted as a function of the OL factor. The dotted line is the regression equation for the annual parts shortages, taken from the preceding figure. In going from OL factor = 3 to 13, the shortage duration actually increases, from 44.6 to 59.1 days, an increase of 33 percent.

The reason for the inverse relation between parts short and shortage duration has to do with the mechanics of the supply system itself. The OL quantity is the quantity ordered when the RP is reached. Until the OL quantity is consumed, there is no reorder; the larger the OL quantity, the less frequently reorders occur.

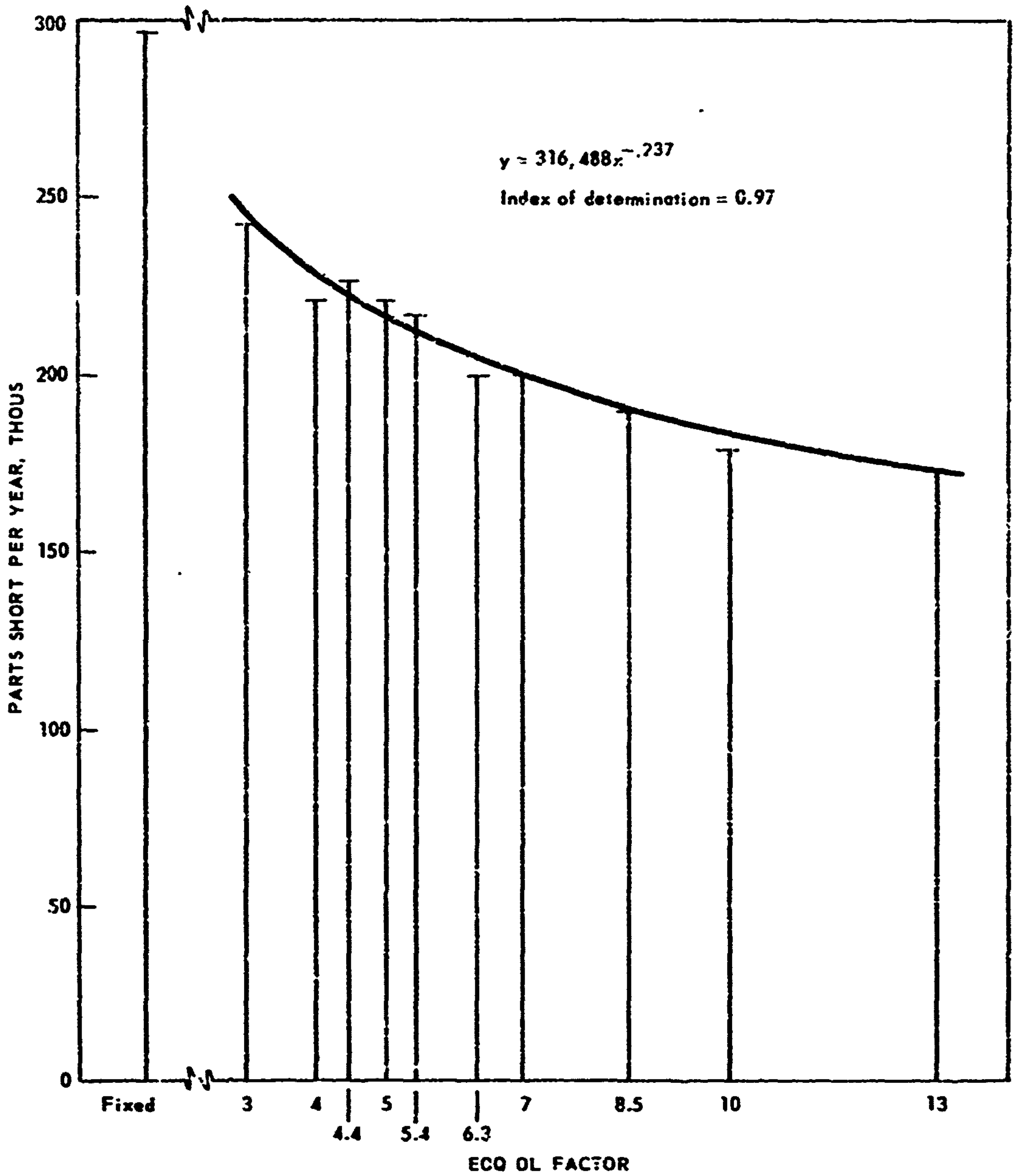

Fig. 19—Annual Parts Shortages as Affected by Stockage Depth Variations

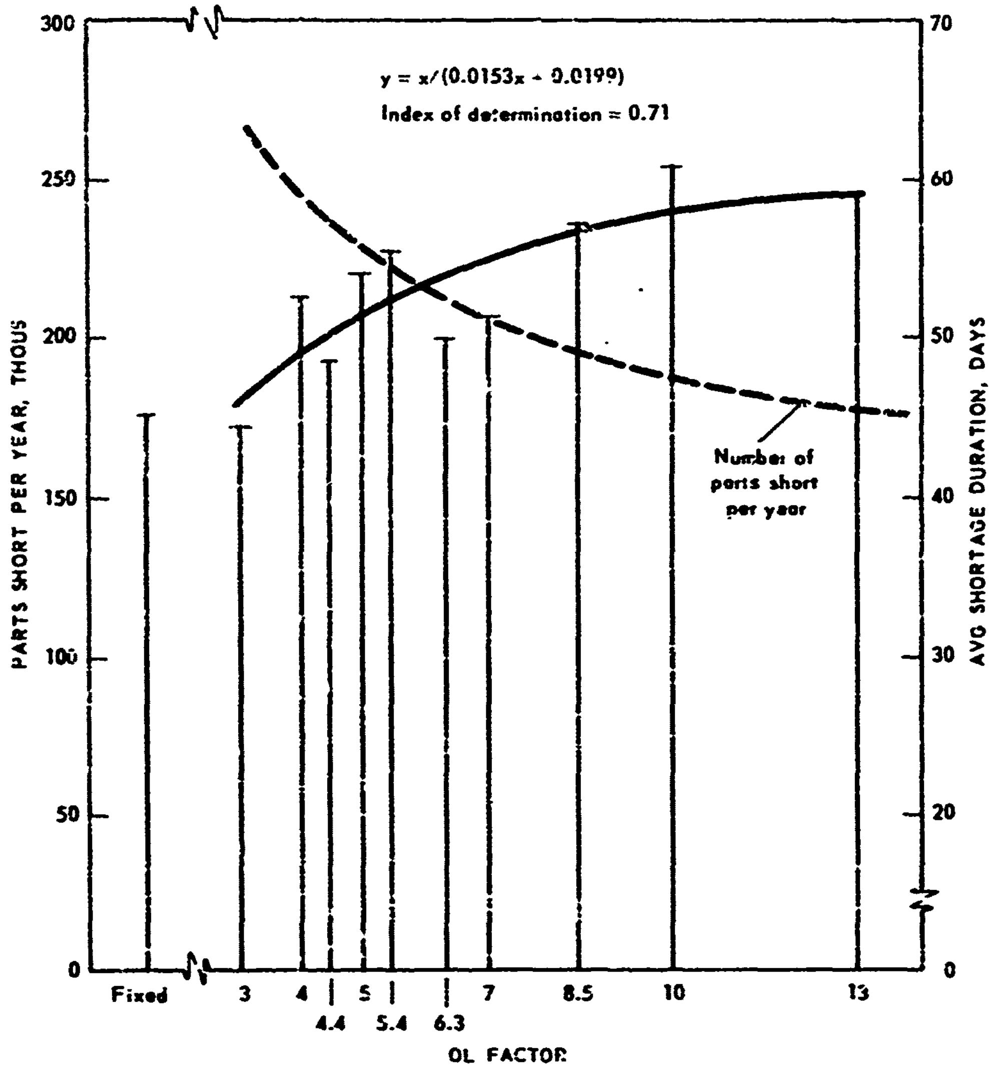

Fig. 20—Parts Short and Average Shortage Duration as Affected by Stockage Depth Variations

The net asset position for a line is the sum of the SOH and on order, less the quantity owed (due out) to customers. A replenishment requisition is initiated each time the net asset position reaches the RP; the quantity then requisitioned is the OL quantity. Thus the net asset position is once again equal to the RO and will not reach the RP again until a quantity equal to the OL is consumed (or requested, if not available). Subsequently, stock on hand for the line may drop far below the RP, but so long as the net asset position is maintained above the RP there will be no reorder. Eventually, when the balance on hand reaches zero, the resulting shortage will trigger a reorder, but that shortage will endure for the length of the OST.

Therefore, although a higher OL factor will reduce the number of parts shortages, it will result in longer duration of the shortages that do occur. Thus there is a tradeoff that must be considered by the policymaker.

Zero Balance Rates as Affected by Stockage Depth

As noted above, increasing the stockage depth results in slightly decreased NORS rates and in fewer parts shortages. These results are influenced considerably by the zero balance rates. As expected, larger OLs result in lower zero balance rates. Thus the overall zero balance rate illustrated by the upper curve in Fig. 21 drops rapidly with increases in OL factor. From an OL factor of 3 to 13, the zero balance drops from 22.7 to 14.2 percent, a decrease of 37 percent.

Zero Balances with Dues-out. More important, however, is the rate of zero balances with dues-out recorded. Existence of a zero balance only takes on importance when a need for the line occurs. Thus the rate of zero balances with dues-out can be considered equivalent to critical zero balances.

The lower curve in Fig. 21 represents the zero balances with dues-out. Note that its slope is much more gradual than that of overall zero balances; going from an OL factor of 3 to 13, the rate drops from 6.3 to 4.2 percent, an absolute decrease of only 2.1 percent. This fact could account for the lack of correlation between NORS and OL factor that was described in Fig. 18.

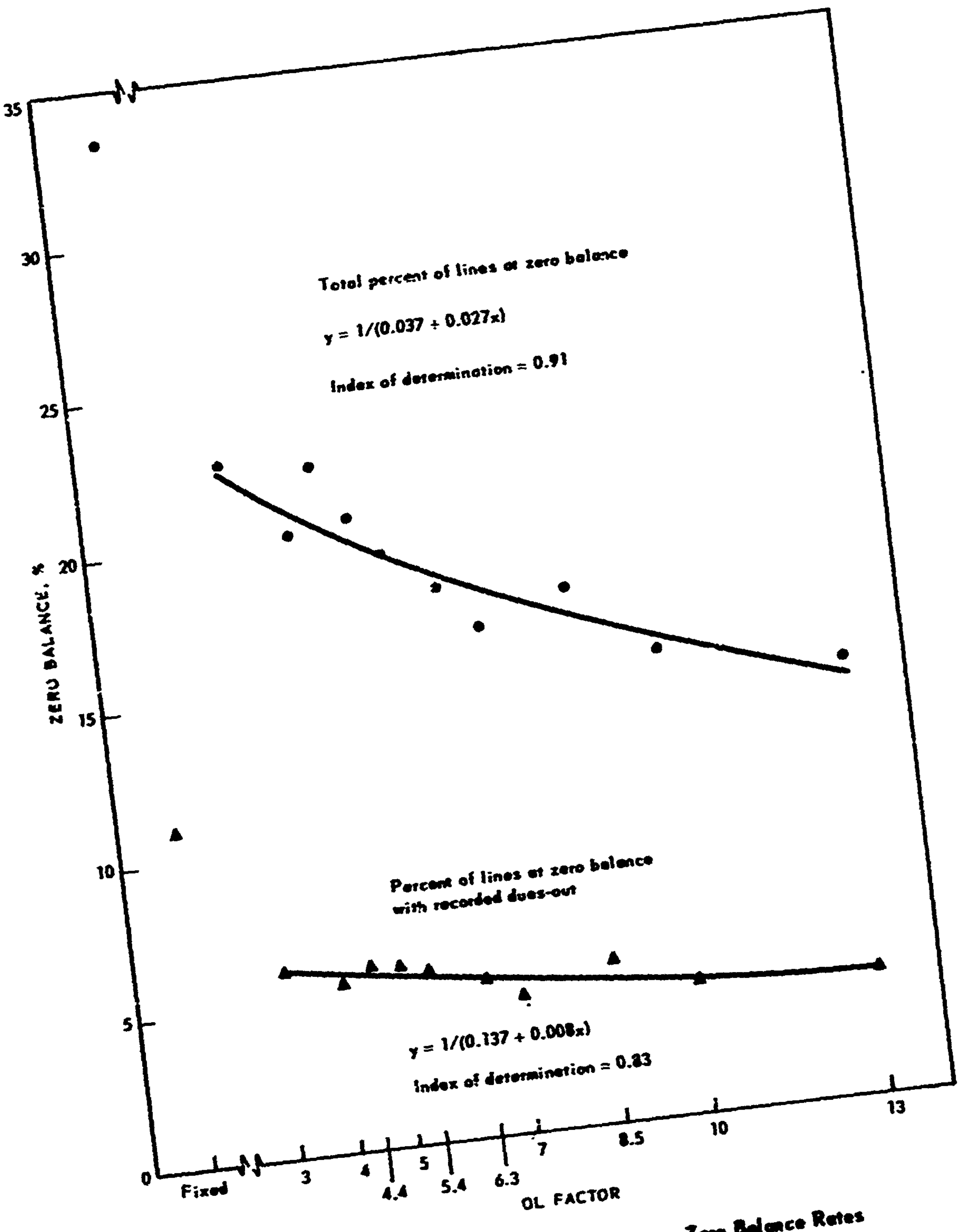

Fig. 21—Effects of Stockage Depth Variations on Zero Balance Rates

Relation of DSU Mobility to Stockage Depth

Changes in the stockage depth can affect the average quantity on hand. By definition, the RO quantity is the maximum quantity of materiel to be maintained on hand and on order. It is the sum of the OL, safety level, and OST level quantities.[10] The OST quantity, however, should always represent assets that are in transit to the DSU (i.e., on order), so that the maximum quantity on hand will be the sum of the safety level and the OL. Average total quantities on hand, therefore, will equal the safety level plus one-half the OL quantity for each line. This average on-hand quantity is derived within the SPSM. Its value (average inventory investment) has been shown in Fig. 16; its weight and cube are given in Fig. 22, as functions of variations in stockage depth.

Clearly, increasing the OL factor increases the weight and bulk of the average inventory on hand markedly. An increase from 3 to 13 in OL factor results in a 94 percent increase in average weight and a 98 percent increase in average cube.

DSU Weight- and Cube-Carrying Capacity. The DSU weight- and cube-carrying capacity has been computed for the storage section of several different TOEs of the main support company, for both mechanized infantry and armored divisions. These may be found in Table 36, Chap. 4. Regardless of which TOE series is in use, the weight-carrying capacity of the storage section is sufficient to carry the average inventory weight shown in Fig. 22.* The minimum weight capacity is 138 tons; the required weight capacity for an OL factor of 13 is 114 tons.

As is discussed in Chap. 4, the limiting factor on the DSU's load-carrying capacity is the space (cube) available in the storage section. Obviously, not all the space capacity can be occupied by parts, as some unoccupied space will be needed for bins allocated to lines currently out of stock, extra space within the bins to provide access to the parts therein, and space reserved for aisles to provide access to the bins themselves.

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*Note, however, that the demand data for DX lines were not included in the computation of inventory weights. Because DX lines are generally major assemblies and components, their weight could be significant.

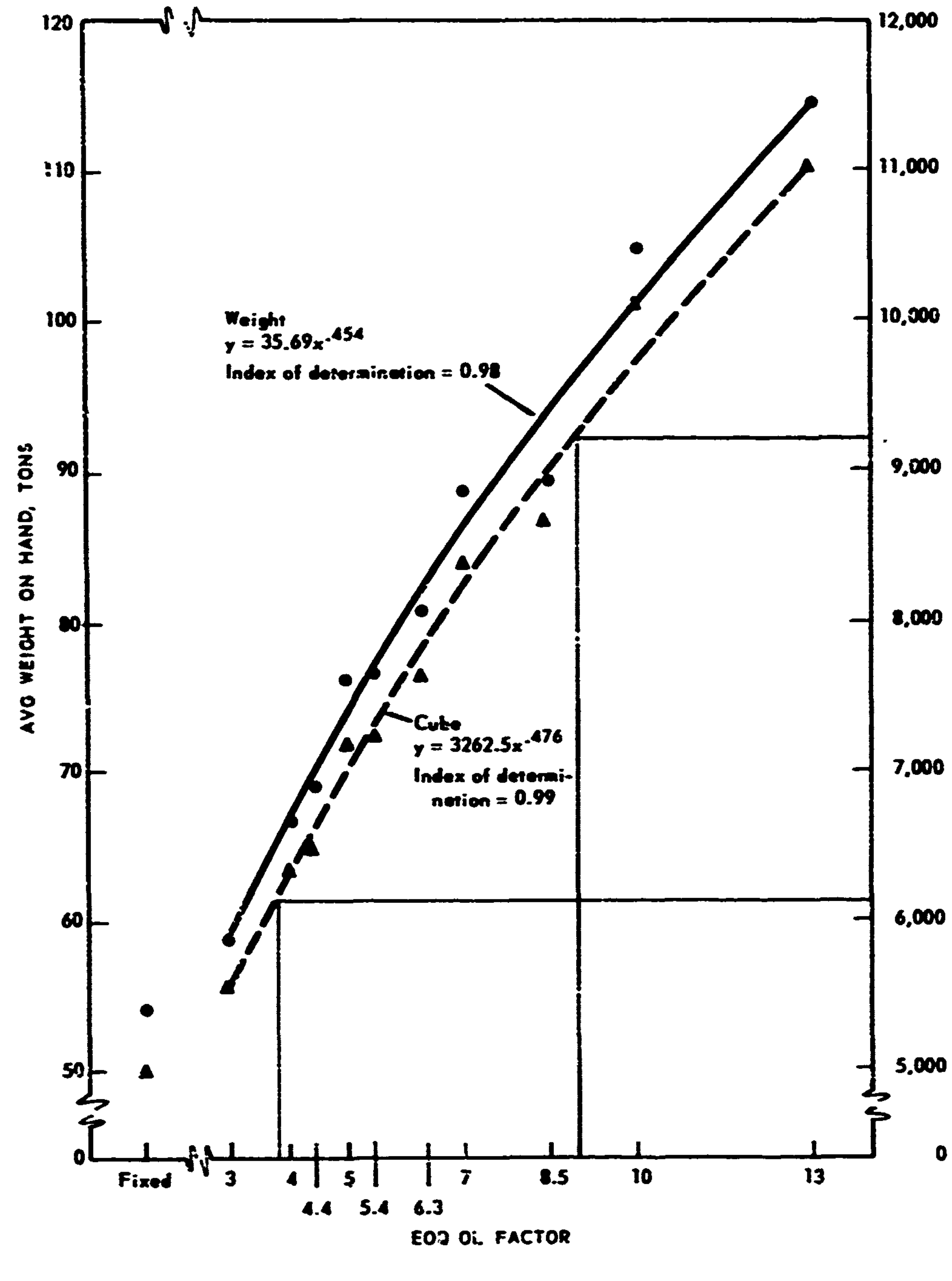

Fig. 22—Effects of Variations in Stockage Depth on Weight and Cube of Average Inventory on Hand

Total available space in the DSU's storage section ranges from about 12,000 to about 18,000 cu ft, depending on the TOE authorized. Based on observation of van and trailer space utilization at the DSUs visited, far less than half of the available space is actually occupied. However, since some parts will be placed on board the vehicles before they leave garrison, it has been assumed for this analysis that 50 percent of total cube capacity will actually be occupied.

Fifty percent of cube capacity ranges from about 6200 to about 9200 cu ft. Referring to Fig. 22, it is evident that the average assets on hand will exceed that capacity when the OL factor is 9 or more. The current Army OL factor is 7.

Fifty percent of the lowest cube capacity will be exceeded for an OL factor any greater than 4.

It is concluded, therefore, that the depth policy selected will have a direct effect on the DSU's capability to carry its parts inventory. The subject of DSU mobility as a measure of mission performance is discussed more extensively in Chap. 4.

Effects of Cost Assumption on Total Variable Cost

Total variable cost is the sum of holding and ordering costs and is generally expressed as an annual total. When the Wilson EOQ is used, the cost to order (C) is counterbalanced by the cost to hold (H x P), in such a way that their sum is minimized. Obviously the higher the ordering cost, the more stocks will be held (the deeper the stockage level); the higher the holding cost, the more frequent the reorders.

Table 19 lists the average annual ordering cost resulting from the various combinations of C and H used in the EOQ.* In general, as C is increased, the annual ordering cost increases, subject also, however, to variations in the holding cost factor assumed. Table 20 shows a similar phenomenon: as H increases, average annual holding cost increases (but also subject to variations in assumed C). Because of

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*If the actual values of C and H were known, the considered variations would not have to be tested. Each assumed combination of C and H describes a stockage depth policy, and the resultant costs are predicated on the accuracy of the assumptions.

Table 19

AVERAGE ANNUAL ORDERING COST

Cost per order, dollars C	Selected holding cost factor H	Resultant EOQ OL factor	Average annual ordering cost, dollars
3.20 [a]	0.40	4	101,392 [a]
3.20 [a]	0.68	3	112,960 [a]
5.00	0.40	5	146,635
5.00	0.50	4.4	151,040
10.00	0.40	7	275,710
10.00	0.50	6.3	286,920
10.00	0.68	5.4	292,560
18.00	0.50	8.5	491,616
20.00	0.24	13	498,440
20.00	0.40	10	529,860

[a]Note that pairs (or sets) of equal ordering cost factors result in different annual ordering costs when H differs. As H increases, fewer assets tend to be held, requiring more frequent orders, thus higher annual ordering cost for a particular C.

the relation between C and H, seemingly unexpected results can occur. For example, OL factor 13 results in the highest inventory investment (Fig. 16) and the highest pipeline cost (see Table 21), yet its associated holding cost is one of the lowest, as seen in Table 20. The associated high ordering cost accounts for the high pipeline and inventory values.

Figure 23 illustrates the relation between total annual variable cost and the C and H assumptions. By attempting a series of least square analyses, the best fit relation tried proved to be the one in Fig. 23, in which cost is related to the product of C x H.

Effects of Stockage Depth on Total Costs

The total cost is defined as the sum of holding, ordering, and pipeline costs. This total (aggregate) cost is given in Table 21. There is an 82 percent increase in total cost from OL factor 3 to 13. When considering the factors currently in use, however, the increase from OL factor 4.4 to 7 is only 13 percent. Thus it would appear that a fairly wide range of acceptable policy alternatives is open to the supply planner.

Important Depth-Related Performance Measures

Using the General Electric time-sharing linear multiple regression program[22], a multiple regression analysis of the relations between tech supply fill rate, the dependent variable and the several independent variables each of which is a performance measure was run. A summary list of the measures selected for use in the multiple regression analysis, and their associated values, appears in Table 22. Table 23 gives the results of the multiple regression. Because the independent variables are expressed in different units, a direct comparison of their coefficients of regression is impossible. Therefore an option was used in the multiple regression analysis that provides a "standardized multiple regression equation" through the calculation of "beta (β) coefficients." The β coefficient is derived as follows:

$$\beta = \text{regression coefficient} \times \frac{\text{std dev of independent variable}}{\text{std dev of dependent variable}}$$

The regression coefficient indicates the net effect on the dependent variable of a unit increase in the independent variable. The net

Table 20

AVERAGE ANNUAL HOLDING COST

Holding cost factor H	Selected cost per order, dollars C	Resultant EOQ OL factor	Average annual holding cost dollars
0.24	20.00	13	100,350 [a]
0.40 [b]	3.20	4	98,719 [a]
0.40 [b]	5.00	5	112,301
0.40 [b]	10.00	7	130,115
0.40 [b]	20.00	10	149,848
0.50	5.00	4.4	128,520
0.50	10.00	6.3	148,870
0.50	18.00	8.5	164,850
0.68	3.20	3	148,874
0.68	10.00	5.4	192,162

[a] Although H increases from 0.24 to 0.40, annual holding cost decreases slightly. This is due to the associated decrease in ordering cost. In the first case the high ordering cost tends to make holding large quantities more desirable; in the second case the low ordering cost favors more frequent orders, and thus fewer parts are generally held in inventory.

[b] For a given H, the annual cost to hold assets increases with increasing C, because larger quantities of assets are held as the penalty cost for ordering is increased, i.e., it is beneficial to order less frequently.

Table 21

AGGREGATE ANNUAL COSTS AS AFFECTED BY STOCK DEPTH VARIATIONS

OL factor	Total holding and ordering cost, dollars	Pipeline cost,[a] dollars	Aggregate cost,[b] dollars
3	261,834	585,601	847,435
4	200,111	724,932	925,043
4.4	279,560	739,755	1,019,315
5	258,936	697,211	956,147
5.4	484,722	751,765	1,236,487
6.3	435,790	750,575	1,186,365
7	405,825	743,555	1,149,380
8.5	656,466	705,607	1,362,073
10	679,708	797,922	1,477,630
13	598,790	944,058	1,542,848

[a] Pipeline cost = acquisition value of assets on hand and on order ($Q_{OH} + Q_{DI} - Q_{DO}$ = pipeline Q).

[b] Total (aggregate) cost = pipeline cost + holding cost + ordering cost.

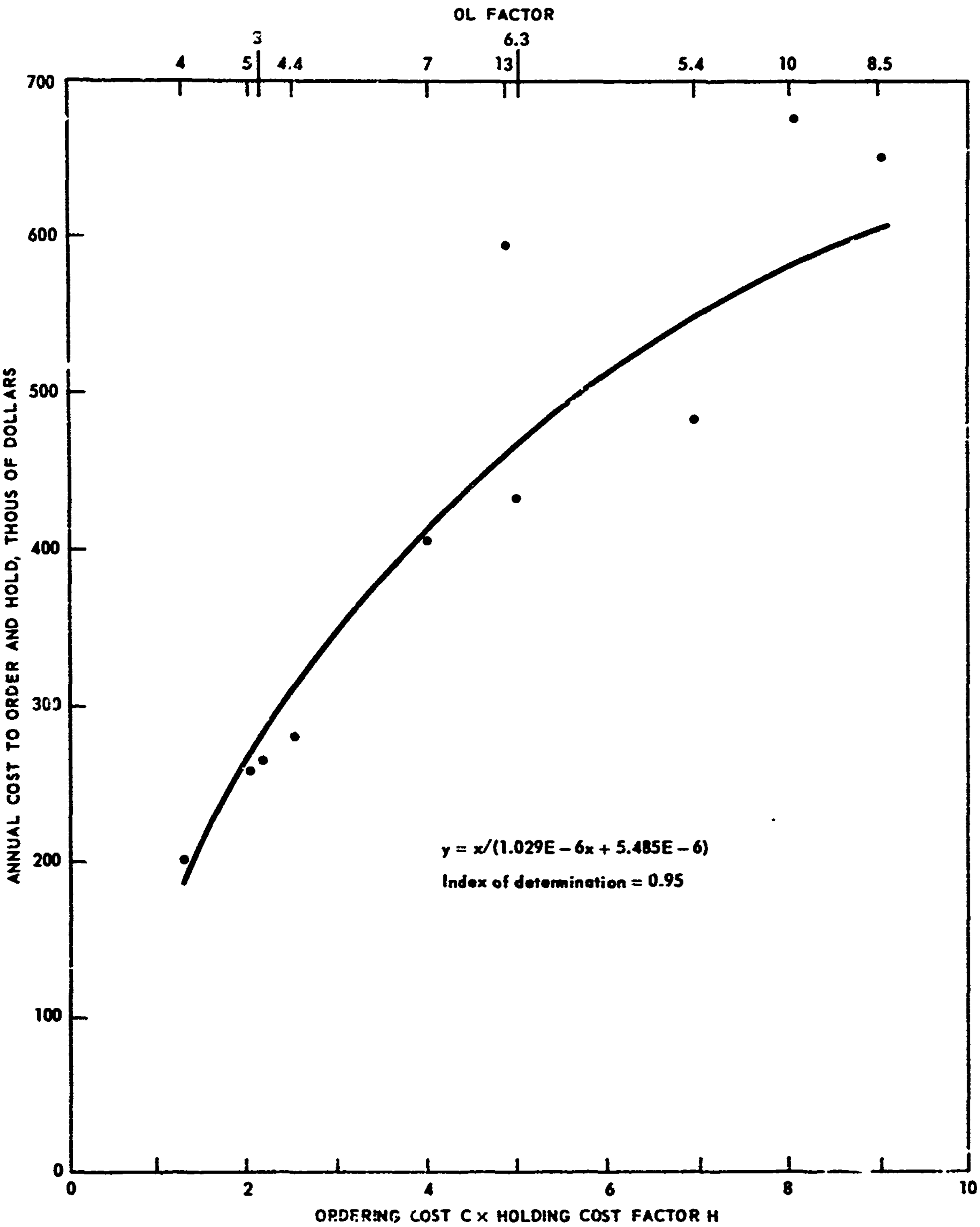

Fig. 23—Annual Cost To Order and Hold Assets, as Function of C × H

Table 22

INPUTS TO MULTIPLE REGRESSION FOR

ANALYSIS OF DEPTH-RELATED MEASURES

OL factor	Tech supply fill rate, %	Zero balance with dues-out, %	Avg inventory, parts	Shortage quantity	Shortage duration, days
3	54.6	6.3	58,442	243,282	44.6
4.4	57.7	5.9	62,529	226,517	48.6
4	60.4	5.7	65,264	221,412	52.5
5	61.1	5.9	69,980	220,670	54.0
5.4	62.1	5.6	70,316	217,531	55.6
7	63.6	4.7	79,212	199,945	51.5
6.3	63.7	5.2	76,691	199,839	49.9
8.5	63.8	5.4	85,995	189,964	57.5
10	67.8	4.3	98.856	179,086	60.9
13	68.0	4.2	110,494	174,998	59.1

effect is the sum of direct relations between the two factors, and any indirect effects of the other factors. By using the β coefficient to develop the standardized equation, the change in the standard deviation of the "...dependent variable resulting from an increase of one standard deviation in each independent variable"[32] can be determined.

From the multiple regression analysis (Table 23) the sensitivity of the tech supply fill rate to other performance measures that are depth-related may be determined. Annual shortage quantity is clearly the most important measure. An increase of one standard deviation (22,102)* in this statistic will cause a 2.52 percent decrease in tech supply fill rate. Similarly, an increase of only 0.71 percent in zero balance with dues-out will decrease fill rate by 1.60 percent. Interestingly, an increase of 16,549 in average inventory on hand will actually reduce fill rate by 1.17 percent. This is apparently because

*Note that the occurrence of one standard deviation from the mean is equally likely in all measures. Therefore 22,102 parts shortages in a year are just as likely as a 0.71 percent increase in zero balance with dues-out.

Table 23

RESULTS OF LINEAR MULTIPLE REGRESSION,[a] STOCKAGE DEPTH-RELATED PERFORMANCE FACTORS

Variable	β Coefficient[b]	Mean value	Standard deviation, σ	Percent change in y owing to σ change in x (β_x x 4.14)	Percent change in y owing to unit change in x[c] $\left(\frac{\beta_x \times 4.14}{\sigma_x}\right)$
Tech supply fill rate (dependent, y)	1	62.3%	4.14%	-	-
Zero balance with dues-out (x_1)	-0.387	5.3%	0.71%	-1.60	-2.25
Avg inventory on hand, parts (x_2)	-0.282	77,778	16,549	-1.17	-7.07 E-5
Annual shortage quantity (x_3)	-0.609	207,324	22,102	-2.52	-1.14 E-4
Avg shortage duration (x_4)	+0.327	53 days	5 days	+1.35	+0.27

[a]The resultant standardized multiple regression equation is

$$\frac{y}{4.14} = \frac{62.3}{4.14} - 0.387\,\frac{x_1}{.71} - 0.282\,\frac{x_2}{16,549} - 0.609\,\frac{x_3}{22,102} + 0.327\,\frac{x_4}{5}.$$

Index of determination = 0.971, F - ratio test statistic = 41.9, degrees of freedom: numerator = 4, denominator = 5.

[b]Change in σ_y owing to σ change in x.

[c]Equivalent to regression coefficient.

of its relation to other factors. Also, an increase of 5 days in average shortage duration will actually increase fill rate by 1.35 percent. See the discussion of Fig. 20 for an explanation of this phenomenon.

Objectives for Depth-Related Performance Measures

Assuming that the current Army policy that assumes C = $10 and H = 0.40 (i.e., OL factor = 7) is retained, certain objectives* emerge for the most meaningful measures of performance. Tech supply fill rate should have an objective of approximately 64 percent. Indeed, if one assumes a stockage breadth policy that yields 80 percent demand accommodation and 80 percent demand satisfaction, the tech supply fill rate will be 64 percent. Zero balance with dues-out should not exceed 5 percent; a 1 percent increase in this measure will decrease tech supply fill rate by 2.26 percent.** Average shortage duration should not exceed 52 days; a more desirable objective would be considerably less than that.

The detailed outputs of the various SPSM runs used in this analysis may be found in App B, Table B6.

PERFORMANCE DERIVED FROM VARIATIONS IN QS STORE COMPOSITION

QS is designed to provide easy access to fast moving low unit cost lines. No formal records of individual demands are maintained, resulting in a considerably simplified system from the customers' standpoint.

Criteria for inclusion of lines in the QS system vary considerably from unit to unit and from command to command. A standard QS policy has recently been adopted by DA.[12] USAREUR has also developed a set of procedures for QS stores.[13] In general terms, both these sets of procedures specify that lines will be selected for QS stockage if they meet the demand criteria required for stockage on the ASL and have a unit price of no more than $5. Under both systems, over-the-counter

*See Table 22

**$\frac{\beta x_1 \times \sigma_y}{\sigma_x}$ = percent change in y, thus $\frac{-0.387 \times 4.14}{0.71} = -2.26$.

issue is practiced, without the need for formal records of individual customer demands. Formal requests are used only when the requested line is out of stock; even then, formal requisitions are passed to the supplier only if they are high priority [issue priority designator (IPD) 01-08.] The important characteristics in which both procedures are essentially alike are summarized in Table 24; the significant policy differences are outlined in Table 25. The crucial differences between the two policies are the DA policy's addition criterion (that the line's EOQ must be at least 90 days' worth of demands), and the USAREUR stockage depth policy (that the QS OL will be 300 days' worth of demands).

The lack of uniformity in QS procedures has been pervasive: there is virtually a different set of procedures for each different DSU. Even within the same maintenance battalion, the forward companies may use detailed accountability, while the main support company does not. Clearly, procedural uniformity is required before a uniform set of performance measures can be adopted for the DSU QS stores.

Responsiveness of Alternative QS Policies

The QS function can provide a significant portion of the total customer service rendered by a DSU. Yet variations in policies regarding QS stockage criteria and depth materially affect the overall quality of a DSU's service. Thus an analysis of the implications of alternative QS policies was warranted. Two basic types of QS policy are considered:

1. The EOQ-type, in which lines are selected for QS stockage on the basis of their unit price and the number of days' worth of demands in their computed EOQ; the operating level used is the EOQ quantity. The DA policy[12] is an example of this type.

2. The larger stockage level type, in which the only basis for selection of lines to stock is their unit price; the operating level used is 300 days' worth of demands. The current USAREUR policy[13] is an operating example of this type.

A considerable number of variations of the above two policies are possible; a few representative ones have been chosen for analysis. One possible variation not analyzed is the "economic inventory policy"

Table 24

QS POLICIES COMMON TO DA AND USAREUR

Policy	Criterion
Addition to QS	1. Line meets ASL demand criterion
	2. Line is not DX, not subjected to special controls, and not especially pilferable
Retention in QS	1. Retain for minimum of 1 year, once added
Stockage depth	1. RP = 60 days
	2. Recompute RO when RP is reached and when zero balance is reached
Issue	1. Over the counter
	2. No formal request
Out of stock	1. Customer must prepare formal request
	2. High priorities (01-08) are passed
	3. Low priorities (09-20) are held in dues-out file pending receipt of replenishment stocks

(EIP),[8] in which both the decision whether to stock and the RO quantity once stocked are controlled by the line's unit price and the number and quantity demanded annually. When the EIP is used, it is applied to all lines to achieve a balance between demand experience and inventory costs. The analyzed QS policies differ from this approach by application of special rules for stockage, and sometimes for stockage depth, to selected low value lines. The paper work required of the user to obtain such lines is reduced as is the number of costly replenishment orders for them.

Another policy variation is that of "summary accounting for low dollar turnover items" (SALTI).[8] In SALTI procedures, an increased stockage depth and simplified issue procedures are superimposed over the existing procedures for the EIP accounts. The operating level for a SALTI line is equal to 1 or 2 years' worth of demands. Because

Table 25

COMPARISON OF QS STORE POLICIES, DA AND USAREUR

Policy		DA Regulation[12]		USAREUR[13]
Addition to QS	1.	Unit price < $5	1.	Unit price ≤ $5; ≤ $10 optional
	2.	OL(EOQ)≥90 days[a]		
Retention in QS	1.	Review semiannually	1.	Review quarterly
	2.	If unit price increases, retain up to $6		
	3.	If no issue for 18 months, delete from QS		
Stockage depth	1.	OL = EOQ	1.	OL = 300 days
	2.	Reserve quantities allowed	2.	Reserve quantities not allowed
Recording of demands for replenishment	1.	Number of issues set equal to number of months elapsed since last replenishment	1.	Number of issues set at 3

[a]Was 180 days.[33]

SALTI procedures are applicable only to Class I and II Installation supply accounts (and therefore not to a DSU), this option was not considered in the analysis.

The current USAREUR policy has evolved from a predecessor system in Europe known as the "country store concept." Though much smaller than the QS store, its objective was similar: to provide ready access to the common hardware lines that are used with such regularity as to make repeated routine requisitioning burdensome, unnecessary, and costly. The QS concept is essentially an expanded country store, with more uniform line selection and stockage depth rules applied. A typical list of QS lines is given in App B, Table B8.

Advantages and Disadvantages of the Studied Alternatives. Clearly, the most significant advantage of any QS policy is easy customer access to the supplies. In either of the two basic types described above, the removal of formal requisitioning except for replenishment has the

effect of reducing ordering cost; this reduction will be greater in the system that results in the fewer orders, i.e., the one in which the operating level is increased. But it must be remembered that the EOQ is designed to optimize (minimize) the sum of ordering and holding costs. Thus it may be argued that stockage of a fixed 360 day RO is economically sound only when the EOQ equals 360 days. Herein lies the major apparent advantage of the EOQ-type QS policy. The larger stockage level type of QS policy, on the other hand, should (intuitively) result in improved performance, because of the greater likelihood that needed assets will be available, i.e., zero balance rates should be lower. Naturally there is a cost penalty associated with this improvement.

In either type of policy the major disadvantage is the loss of detailed demand history information once the line is placed in the QS store. Doubtless a scheme could be devised to capture these data, though it might not be worth the expense.

Alternative Policies Compared. The intuitive advantages and disadvantages of the two types of QS do not provide a basis for judging which is the more desirable. Therefore a series of alternatives, each a variation on one of the two described types, was simulated using the SPSM, and the resultant performance was compared. Data used were from division C. The alternatives considered are listed in Table 26. The simulations were of two types: in the first, activity was simulated for all demanded lines in order to provide expected differences in total system performance as a function of variation in QS policy; in the second, performance of the QS store as an entity was considered.

Use of the EOQ-type QS policy will provide the same overall system performance as would be experienced with no QS store at all. In the EOQ-type, QS lines and all other lines are only different in terms of materiel handling and paper work requirements...there are no differences in the order frequency or in the order quantity, as the EOQ OL is used in both cases. Therefore only one simulation (denoted run A in Table 26) was required to derive the overall performance resulting from the EOQ-type QS policy.

Since the QS store is a separate function, the performance it provides as an entity will have a direct bearing on customer condidence

Table 26

ALTERNATIVE QS POLICIES ANALYZED

QS policy (run number)	QS stockage criteria		OL	Review frequency
	Unit price, dollars	Minimum EOQ		
I. Simulations of all ASL lines:				
A[a]	0-5	90 days	EOQ	Quarterly
B[b]	0-5	-		
C	0-1	-		
D	0-2	-	QS lines 300 days, all others EOQ	QS lines annual, all others quarterly
E	0-3	-		
F	0-4	-		
II. Simulations of QS lines only:				
G	0-5	90 days		
H	0-5	135 days	EOQ	Quarterly
J	0-5	180 days		
K	0-5	-		
L	0-1	-	300 days	Annual
M	4-5	-		
N	4-5	-	EOQ	Quarterly

[a]DA policy.

[b]USAREUR policy.

in the supply system as a whole. In order to isolate this segment of the overall performance, specific runs were made simulating activity for only those lines stocked in QS according to the rules of the variation being tested. These runs are listed in Sec II of Table 26. Note that, when the QS store is considered as an entity, stockage selection criteria affect performance of that entity, both for the larger stockage level type and for the EOQ-type. Additional lines in the QS store account for the difference, even though overall system performance does not vary for the different EOQ-type policies.

Importance of Good QS Store Performance

The importance of the QS store to the overall supply performance of the DSU cannot be overemphasized. As shall be seen, the proposed QS systems would accommodate a significant portion of the DSU's business.

Customer units generally rely on support from their own battalion supply sections for those supply lines that are of sufficiently frequent demand to warrant stockage on the prescribed load list (PLL). For PLL lines that are out of stock, and for all lines not stocked, reliance must be placed on the DSU. By their nature, QS lines tend to be those that experience relatively frequent demands. Indeed the DA policy specifies stockage only for low unit price items whose EOQs are at least 90 days, thus ensuring that QS lines will be active lines. It is logical to expect that many of these lines will experience sufficiently frequent demands to qualify for stockage on the customer units' PLLs. Three demands within 180 days are required for addition of a line to the PLL, and only one demand in 180 days thereafter to retain it.[8] However, in a message to most major Army commands,[34] DA policy on PLL composition was amplified: "...items readily available through over the counter issue systems such as quick supply stores...will not be included on PLLs." Indeed, the USAREUR policy has had such a provision since September 1969, ensuring "...that only high demand items were included in PLLs...[by placing] high demand common items in the QS store which precluded stockage of these items in unit PLL's."[35] This exclusion of the QS lines from the customers' PLLs places considerable reliance on the QS store for fill of these lines. Therefore performance of the QS store as an entity is important.

Results of Analysis of Alternative QS Policies

Overall Performance. Regardless of the QS policy employed, overall supply performance for tech supply plus the QS store hardly varies. Consider Table 27, in which supply performance for the combined tech supply and QS is presented. Because the stockage criteria are the same regardless of which policy is applied, the total ASL size is always about 4400 lines for the DSU simulated. Though the differences in overall fill rate may not be significant, there appears to be a real difference between the EOQ-type policy and each of the variations on the larger stockage level type. Also, there appears to be some slight advantage to the latter with regard to lines at zero balance with unfilfilled requirements.

Pipeline Value. Pipeline value is computed by multiplying the average unit price per line by its average pipeline quantity. The pipeline quantity is the sum of assets on hand and due in, less the quantity due out. As the dollar criteria for stockage in the larger stockage level type QS are expanded, i.e., as the QS list is increased incremently from inclusion of lines of no more than $1 in unit price up to inclusion of lines of unit price of $5, the overall pipeline value increases accordingly, reaching a high of over $720,000. In the DA policy, represented by run A in Table 27, the pipeline value is approximately $755,000, 5 percent greater than the USAREUR policy . This difference, as will be illustrated later, appears to be due to the difference in lines stocked in the QS store.

Performance of the QS Store Segment. Table 28 identifies the contribution of the QS store itself to overall supply performance.

The EOQ-type QS. Two variations on the DA policy, each aimed at reducing the total number of QS lines stocked, are included with the runs H and J. An earlier version of the DA policy[33] had specified that the EOQ must be at least 180 days' worth of demands for addition to the QS list. Under such a policy the 628 lines stocked would provide a QS demand fill rate of only 31 percent; indeed if the criteria were expanded to include those items of 135 day EOQ (run H) the QS fill rate would only be increased to about 40 percent. This level of QS performance is almost certainly inadequate because it would result in a serious degradation of customer confidence in the supply system.

Table 27

OVERALL SUPPLY PERFORMANCE, TECH SUPPLY + QS, UNDER VARIOUS QS POLICIES

QS policy		Total ASL items stocked	Fill rate, %		Zero balance with unfulfilled requirements, %	Pipeline value, dollars
Run number	Type		Demands	Quantity		
A[a]	0-5/90 EOQ		64.6	59.9	6.4	755,081
B[b]	0-5		67.7	64.6	5.6	719,799
C	0-1	4373[c]	66.2	63.5	5.6	658,736
D	0-2 300		68.2	65.2	5.3	672,740
E	0-3		69.8	66.1	5.3	694,961
F	0-4		68.6	65.3	5.4	708,480

[a]DA policy.

[b]USAREUR policy.

[c]Total ASL size is the same for all policies; stockage addition-retention are 6-3 in 360 days.

Table 28

SUPPLY PERFORMANCE PROVIDED BY QS STORE ONLY
UNDER VARIOUS QS POLICIES

QS policy		Number of QS lines stocked	QS fill rate, %		Zero balance with unfulfilled requirements, %	Pipeline value, dollars
Run number	Type		Demands	Quantity		
G	0-5/90 EOQ	2894	68.9	67.0	10.6	121,643
H	0-5/135 EOQ	1163	39.7	37.7	11.3	10,828
J	0-5/180 EOQ	828	30.7	25.8	12.2	6,799
K	0-5/300	2930	76.1	68.7	3.3	222,253
L	0-1/300	1686	73.5	65.7	2.9	50,038

Increasing the criteria to include all lines whose EOQs are 90 days or more significantly improves performance of the QS store segment. Because the stockage depth for lines in the QS store remains the same as for all other ASL lines, the rate of zero balance with unfulfilled requirements is a rather high 10.6 percent.

The larger stockage level type QS. The performance of the QS store as represented by run K, the USAREUR policy, is notably improved over the EOQ-type policy because of the increased stockage levels for QS lines. Although there is very little difference in the total number of lines stocked, the demand fill rate increases from 69 to 76 percent, a 10 percent increase, and the rate of zero balance with unfulfilled requirements decreases to only 3.3 percent. By limiting the QS list to those lines of unit price of $1 or less (run L), QS store performance is only slightly degraded, although the number of QS lines is cut almost in half.

Note the significant difference in QS pipeline value between runs K and L in Table 28. The performance of QS as an entity is not seriously degraded by limiting QS stockage to lines of unit price of $1 or less; yet the pipeline investment required is decreased markedly. The difference is due to two things: (1) lines of unit price $2 to $5 are not included in the L run; (2) the same lines are included in the K run, and their OLs are 300 days. The real difference in overall pipeline value between these two options is illustrated by runs B and C in Table 27. The $2 to $5 lines are included in run B with 300 day OL quantities and are included in run C with EOQ OL quantities. Thus the actual difference is approximately $61,000.

QS List Composition. The detailed composition of the stockage lists resulting from application of the various QS policies is presented in Table 29. Clearly the rates of zero balance for the larger stockage level type policies are better than that of the EOQ-type policy. However, consideration must be given to the large average number of parts that would be on hand when a 300 day operating level is used for all lines of unit price of $5 or less (run K). The resultant weight and space consumption of these parts may be important with regard to the DSU's mobility. Assets for QS items would almost certainly

Table 29

COMPOSITION OF QS STORE STOCKAGE LISTS
UNDER VARIOUS QS POLICIES

QS policy		Number of QS lines stocked	Average inventory on hand				Zero balance, %
Run number	Type		Parts	Value, dollars	Weight, tons	Cube, cu ft	
G	0-5/90 EOQ	2894	69,065	63,086	22.2	2,467	22.9
K	0-5/300	2930	152,385	159,481	56.4	6,306	12.1
L	0-1/300	1686	100,298	35,449	19.9	1,998	11.6
-[a]	0-2/300	2188					
-[a]	0-3/300	2496					
-[a]	0-4/300	2735					

[a]No simulation runs for "QS items only" under these policy alternatives.

be moved with combat units in the event of an emergency or training exercise. As noted above, QS lines are high demand items commonly required by most (or all) customer units. By limiting the criteria to those lines of no more than $1 unit price, their weight and space consumption could be considerably restricted while not significantly degrading performance. If demand qualified, the remaining lines ($2 to $5 unit price) could be carried by individual units as required, as part of their PLLs.

The final three options shown in Table 29 may be expected to result in average on-hand inventories proportional to the number of QS lines stocked. As no individual "QS only" simulations were run for these alternatives, no other results could be included in the table.

QS/ASL Ratio. The QS/ASL ratio is the fraction of total ASL lines that are issued through the QS store. It is a measure of the manageability of the QS function; DSU commanders with too large a QS/ASL ratio run the risk of losing control of the supply operation. Because the quantity of assets on hand is the primary determinant of when to recompute the RO, stockage quantities could become excessive in some cases and inadequate in others before DSU personnel become aware of wide fluctuations in demands.

Table 30 gives the QS/ASL ratio for the QS policy alternatives considered. The DA policy (run A) would result in a ratio of 0.66,

Table 30

QS/ASL RATIO

Run number	QS policy	Lines on stockage lists		QS/ASL ratio
		Total ASL	QS only	
A	0-5/90 EOQ		2894	0.66
H	0-5/135 EOQ		1163	0.26
J	0-5/180 EOQ	4373	828	0.19
B	0-5/300		2930	0.67
C	0-1/300		1686	0.39
D	0-2/300		2188	0.50
E	0-3/300		2496	0.57
F	0-4/300		2735	0.63

i.e., the QS list would constitute 66 percent of the total ASL. This suggests that demands will be recorded and issues controlled on only 34 percent of the lines stocked. The USAREUR policy (run B) has a similar effect. The more reasonable policy choice, based on the QS/ASL ratio, would be the $0 to $1 option (run C), wherein the ratio is 0.39.

Because of the similarity between the DA policy and the USAREUR policy with regard to the size of the QS list, a commonality analysis of the lines on each seemed appropriate. Table 31 gives the results.

Table 31

COMPARISON OF LINES ON QS STORE STOCKAGE LISTS, DA AND USAREUR

Policy	Number of QS lines stocked	Number common to both policies	Unique QS lines stocked
DA	2894	2894	0
USAREUR	2930		36

All lines that would be stocked under the DA policy would also be stocked by the USAREUR policy. Even so, the performance of the QS store segment would be better under the USAREUR policy (see Table 28), owing to its larger operating level for most lines and, to a lesser extent, because of stockage of 36 additional lines in the QS store.

Holding and Ordering Costs. The implied annual costs to hold assets and costs to reorder are given in Table 32. Holding cost is assumed, for this analysis, to be 40 percent of average inventory value; ordering cost is assumed to be $10 per order.

Holding cost advantages accrue to the DA policy, because its OL is the smallest. And, even though the implied ordering cost of the DA policy is greater than in any of the other alternatives owing to greater order frequency, the overall holding plus ordering cost is less than for most of the other alternatives.

Selecting the Best QS Stockage Policy

As was illustrated in Table 27, there is essentially no difference among the various policies considered in terms of the overall supply

Table 32

IMPLIED ANNUAL HOLDING AND ORDERING COSTS
UNDER VARIOUS QS POLICIES

Run number	QS policy	Implied annual costs, thous of dollars		
		Holding	Ordering	Total
A	0-5/90 EOQ[a]	168	276	444
B	0-5[b]	201[c]	251[d]	452
C	0-1	172	269	441
D	0-2 300	182	264	446
E	0-3	189	262	451
F	0-4	192	258	450

[a]DA policy.

[b]USAREUR policy.

[c]Holding cost is greater than in the DA policy because OL = 300 days instead of OL = EOQ.

[d]There are fewer orders per FSN than in the DA policy.

performance they yield. Indeed, when the DA and USAREUR policies are compared, the only notable difference in QS store performance itself is in the rate of zero balances with unfulfilled requirements. Thus it is difficult to select the preferable policy.

Recalling Table 25, however, it may be noted that the procedures involved with the selection criteria for stockage on QS and the procedures for calculating the OL quantity are considerably more complex in the DA policy. Because QS is essentially a manual process, the DA policy may prove overburdening to the DSU supply clerk. In addition it will require more frequent replenishment requisitions, and the higher zero balance rate will result in slightly more instances of nonfill. Based on its relative simplicity, then, the USAREUR-type policy would seem to be preferable.

Further, a restriction of the range of stockage, such as that in run C, would appear to have some advantages. Stocking only those lines of unit price of $1 or less will mean fewer lines for which to compute stock levels and fewer lines of potential pilferage value

being stocked in QS. The resultant QS list would be easier to handle and would provide customer service almost as good as that provided by the USAREUR policy.

Performance Measures and Objectives for QS

Based on the SPSM analysis described, certain performance measures emerge as being especially meaningful for QS operations. These are the QS fill rate, the QS zero balance with unfulfilled requirements, and the QS zero balance (because it may be difficult to maintain records of the unfulfilled requirements). The QS/ASL ratio is not a particularly important measure because, once the policy is selected, that ratio is essentially predetermined.

Assuming that the DA policy is implemented, Table 28 would suggest that QS fill rate might have an objective of about 65 to 70 percent and that the goal for zero balance with unfulfilled requirements should be no more than 10 percent.

Assuming adoption of the larger stockage level type policy, with upper limit restriction of $1 unit price, the goal for zero balance with unfulfilled requirements might well be set at 3 percent, and the fill rate objective set at 70 to 75 percent.

SUMMARY

This chapter covers the major performance measures that are directly related to and affected by supply policy. The SCM and SPSM have been used extensively to evaluate the sensitivity of each of these measures to variations in supply policies for stockage breadth, stockage depth, and those related to QS store operations. Reasonable, attainable objectives for most of these measures were developed from the simulations and related analyses. Before selecting an objective, fluctuations in the measure due to possible policy revision and predictable variations in demand and time distributions were examined. Thus, each objective or range of objectives that has been suggested does not conflict with other policy-related objectives.

Table 33 summarizes the measures evaluated and the objectives selected that were described in this chapter. Several of the listed objectives were derived from their sensitivity to both breadth and depth policy variations. These include tech supply fill rate and quantity fill rate, zero balance with dues-out, and NORS.

Table 33

SUMMARY OF MAJOR POLICY-RELATED SUPPLY PERFORMANCE MEASURES AND OBJECTIVES

Performance measure	Importance of this measure	Suggested objective	Basis for selecting this objective
Demand accommodation	Directly affects tech supply fill rate, an important measure	82%	SCM, SPSM[a]
ASL size	In current use	Variable	SCM
Tech supply fill rate	Important measure, directly affects NORS	64%	SPSM
Tech supply quantity fill rate	Important measure, has direct effect on NORS, considers partial fills	60 - 64%	SPSM
ASL turbulence	Affects DSU workload	1%	SCM; 1% feasible if 9-1 criteria adopted
ASL fill rate	Directly affects tech supply fill rate and NORS	71%	SPSM, for NSL fill rate no more than 30%
NSL fill rate	Current interest	---[b]	SPSM and empirical data
Zero balance with dues-out	A measure of system performance that directly affects DSU performance	< 5%	SPSM
Avg inventory value	Becomes important when financial constraints are imposed, owing to its direct effect on tech supply fill rate	---[b]	SPSM
NORS	Primary measure	< 5%	SPSM
Annual shortage quantity	Direct effect on tech supply fill rate	< 200,000 parts	SPSM and multiple regression analysis
Avg shortage duration	Direct effect on tech supply fill rate	< 52 days	SPSM and multiple regression analysis
QS list size	Manageability of manual QS store	1700 lines	SPSM; USAREUR-type QS, QS if unit price ≤ $1
QS fill rate	Support of customer requirements for non-PLL lines	70%	SPSM
QS zero balance with unfulfilled requirements	A measure of system performance that directly affects DSU QS performance	< 3%	SPSM; achievable for suggested QS policy

[a]In each instance, the SCM and SPSM were used with empirical data.

[b]A more complete historical record is required before an objective can be rationalized.

Several of the objectives are predetermined by others. For example, assuming that the current Army depth policy is in effect, and that OST is not improved substantially, an annual shortage quantity of approximately 200,000 parts will yield an average shortage duration of about 52 days.

A few of the objectives listed in Table 33 are predicated on changes to current policy. ASL turbulence will be approximately 14 percent annually if the current Army stockage criteria of 6-3 are retained; adoption of the 9-1 criteria for DSUs is recommended because turbulence can be drastically reduced with no ill effects on other performance parameters. Objectives for QS list size, fill rate, and zero balance with unfulfilled requirements all presuppose adoption of a modification to the USAREUR-type QS policy, in which lines are selected for QS stockage only on the basis of unit price: any demand-supported line of unit price $1 or less becomes a QS line. Continuance of the current DA policy would mean unnecessarily complicated procedures, and an especially high rate of zero balances with unfulfilled requirements.

Chapter 4

ADDITIONAL MEASURES OF DSU SUPPLY PERFORMANCE

In the course of analyzing supply performance, several measures other than those discussed in Chap. 3 were considered important and worthy of detailed presentation. These are set forth below in a sequence reflecting the authors' judgment of their relative importance.

ASL MOBILITY INDEX

The TOE of the main divisional DSU indicates that the DSU is to be 100 percent mobile, using the vehicles assigned to its supply section.[36,37] The ASL mobility index measures a DSU's capability to move its ASL in a single displacement with its own transportation. The formula is:

$$\frac{\text{ASL lines transportable}}{\text{Total ASL lines}}(100) = \text{ASL mobility index, percent}$$

The number of ASL lines transportable may be determined by counting the number of lines stored on vehicles. This presumes that the fullest use of on-vehicle space will be made consistent with ready access to stocks for normal operations.

Table 34 presents the TOE carrying capacities of the main support companies of infantry and armored divisions. The more recent TOEs have reduced capacities. The column giving cube capacity for 50 percent utilization recognizes that the unit will not be able to use the full space available, owing to the need for aisles shelves, and drawers.

An in-process review of DSS reported that an armored division in Europe was able to move only about 40 percent of its ASL.[38] Thus three shuttles would be needed to move the ASL. Analysis of SOH for an infantry division as of 15 March 1971[39] indicated approximately the same situation. Table 35 shows that a similar situation existed in December 1971. Earlier work has demonstrated that cube is the limiting factor for on-vehicle storage.[39]

Table 34

DSU CARRYING CAPACITY

Series TOE	Date	Cross-country weight capacity, tons	Cube capacity, cu ft Total	50% Utilization
Inf Div (Mech)				
29-26E	Jul 63	162	16,587	8294
29-26G	Mar 66	141	12,921	6461
29-26H	Nov 70	138	12,515	6258
Armd Div				
29-36E	Jul 63	173	18,435	9218
29-36G	Mar 66	143	13,357	6679

Table 35

SOH WEIGHT AND CUBE, MAIN DSUs, DECEMBER 1971

Type of line	Division A Weight, tons	Division A Displacement, cu ft	Division C Weight, tons	Division C Displacement, cu ft
ASL	141	9,633	212	15,124
Demand-supported only	140	9,481	160	13,149
NSL	83	7,230	46	5,866
Total (ASL+NSL)	224	16,863	258	20,990

ASL mobility is considered to be critical, as suggested by the 100 percent mobility specification of the TOEs. But actual DSU SOH suggests that this is unattainable. SPSM outputs support this finding (Table 36.)

Table 36

WEIGHT AND CUBE OF AVERAGE SOH FROM SPSM

Item	Division A	Division C
Weight, tons	251	89
Displacement, cu ft	22,500	8400

Tonnages and cubic displacements shown above for SOH do not include major assemblies and DX components. Thus the numbers in Table 35 and 36 may be understated by a substantial amount.

In light of the above findings, an interim objective of 50 percent is advanced for the ASL mobility index. To accept an index of 50 percent is to also accept semi-mobility for ASL stocks as well as its attendant implications for customer units.

USE OF DEADLINING PARTS AS A PERFORMANCE INDICATOR

The measure of current supply readiness posture most commonly used by the Army is NORS. NORS is a measure of a combat unit's readiness to perform its mission, as reflected by the not-ready rates due to lack of required repair parts either at the unit itself (organizational NORS) or at the DSU (support NORS). But NORS fails to isolate the problem; it is only an indication that a parts shortage condition exists, and it quantifies the result of that shortage as reflected in equipments deadlined.

Identifying the Deadlining Parts

The repair parts that have historically affected combat readiness may be identified from the unit's Materiel Readiness Report,[40] DA Form 2406. The front of the form contains the noun, model number, and line number of each reportable equipment type on hand at the preparing unit. Days available and nonavailable are entered, and it is these data that provide the NORS and NORM rates. Space is provided on the reverse side of the form for itemizing the specific NOR equipments by serial number. The reason for nonavailability is indicated, and if NORS, the required repair parts may be listed by FSN and noun.

Most customer units submit such a Materiel Readiness Report every week. Though not all are required to list the FSNs of the parts causing deadline, enough do so to allow certain statistical analyses of the deadlining parts. The study team was able to microfilm historical copies of these reports from three sources: the 82d Abn Div at Ft Bragg, N.C., and the 1st Armd Div and 2d Armd Cav Regt in Germany. Unfortunately, because the 1st Armd Div data are quarterly summary reports, there is no way to determine from them the length of time deadlined or the number of different times deadlined. Nevertheless the FSNs that caused deadline were duly recorded and added to the total sample (Table 37).

Table 37

SAMPLE OF DEADLINING PARTS

Source of data	Inclusive dates	Total number of unique:				
		Readiness-affecting lines (FSNs)	Equipments deadlined	Instances of deadline	Equipment-weeks of deadline	Units
82d Abn Div	May 69-Jun 71	1739	1571	2324	7,554	32
2d Armd Cav Regt	Jan 71-Jan 72	1752	766	1596	9,638	5
1st Armd Div	Jan 71-Dec 71	865[a]	580	-[b]	-[b]	30
			2917	3920	17,192	67

[a]The relatively small number of unique FSNs probably indicates some missing data, and hence the results of this analysis are probably conservative.

[b]The only available readiness data from 1st Armd Div were quarterly summaries. No dates of deadline appear on these, and no count could be made of equipment-weeks of deadline.

The number of different equipments deadlined is determined from the number of different serial numbers listed as deadlined for parts. If no FSN was given for the deadlining part, that piece of equipment was dropped from the sample.

The date that the serial-numbered equipment is deadlined was recorded; each unique combination of serial number and date of deadline constituted one "instance" of deadline. Even if the same serial number was deadlined for several months, it was counted as only one instance of deadline, so long as the date of deadline never changed.

Each unique serial number and report date combination constitutes 1 equipment-week of deadline. Thus, 2 equipments deadlined for 1 week would be counted as 2 equipment-weeks of deadline; 1 equipment deadlined for 3 weeks would be 3 equipment-weeks of deadline.

Parts That Cause Equipment Deadlines in Several Units

Based on the thesis that the repair part that causes an equipment to be deadlined in one unit is likely to cause deadlines in other units, a count was made of the number of different customer units in which each FSN caused at least one instance of deadline. The results are listed in Table 38. Only 717 different FSNs were responsible for all the cases of two or more units with recorded deadlines for the same FSN.

Table 38

DEADLINES CAUSED BY THE SAME LINE (FSN)
IN SEVERAL UNITS

Number of different units in which the same FSN caused deadline(s)	FSNs causing deadline(s) in this number of units		
	Number in this group	Cumulative number	Cumulative percent
>15	4	4	0.1
11-15	11	15	0.4
6-10	41	56	1.6
5	39	95	2.7
4	69	164	4.6
3	148	312	8.8
2	405	717	20.1
1	2849	3566	100.0

This is especially significant in light of the fact that the pieces of equipment deadlined are in three different types of organization: an armored cavalry regiment and an armored division in Europe, and an airborne division in the US. Naturally, all these have certain common equipment types, such as the $\frac{1}{4}$-ton truck.

The statistics in Table 38 suggest that it may be worthwhile to establish a central deadline data collection and reduction facility in corps areas, in theaters, and/or in DA. A master catalog of the relatively few FSNs causing deadline could be maintained by equipment application, and, based on end item densities supported by the various DSUs, appropriate criteria for their stockage could be developed.

Multiple Deadliners

Table 38 lists the number of different units in which the same FSN caused deadline of at least one piece of equipment. Because some of these FSNs caused more than one instance in one or more of the units sampled, the cases of multiple equipments deadlined were tabulated, without regard to which unit owned the equipment. The count was made on the basis of unique serial numbers, and its results appear in Table 39. Only 17 FSNs account for 565 of the total serial-numbered equipments deadlined for parts. Surely these FSNs should be on the stockage list of every DSU that supports any appreciable number of the applicable end items.

Equipment-Weeks of Deadline - A Time-Weighting Technique

The longer a piece of equipment is deadlined, the more effect it has on overall readiness. NORS is a time-related measure; it is the fraction of total time during which the equipment is not operationally ready.

Equipment-weeks gives equal weight to deadline duration and to deadline frequency. That is, an FSN causing each of 3 equipments to be deadlined for 2 weeks counts as 6 equipment-weeks, as does an FSN deadlining 1 end item for 6 weeks.

Table 40 gives the counts for multiple equipment-weeks of deadline. A mere 139 FSNs account for one-third of total equipment-weeks of deadline. Only 364 FSNs (10 percent of the parts causing deadlines) account for 50 percent of all equipment-weeks of deadline reported fo

Table 39

MULTIPLE EQUIPMENTS DEADLINED
BY THE SAME LINE (FSN)

Different equipments deadlined by the same FSN		FSNs causing this number of different equipments deadlined		
Number of different equipments/FSN	Number of equipments in this group	Number in this group[a]	Cumulative number	Cumulative percent
> 20	565	17	17	0.5
16-20	282	16	33	0.9
11-15	345	27	60	1.7
10	70	7	67	1.9
9	117	13	80	2.2
8	192	24	104	2.9
7	196	28	132	3.7
6	246	41	173	4.9
5	335	67	240	6.7
4	552	138	378	10.6
3	621	207	585	16.4
2	1140	570	1155	32.4
1	2411	2411	3566	100.0

[a]Total number of different equipments deadlined for parts = 2917. Note that this column may not be totaled, because serial numbers appearing in one group may also appear in a different group (for different FSNs). I.e., most equipments are deadlined for more than one FSN.

Table 40

MULTIPLE EQUIPMENT-WEEKS OF DEADLINE
CAUSED BY THE SAME LINE (FSN)

Equipment-weeks of deadline caused by the same FSN			FSNs causing this number of equipment-weeks of deadline		
Number of equipment-weeks/DL	Total equipment-weeks in this group	Cumulative % of total equipment-weeks	Number in this group	Cumulative number	Cumulative percent
> 50	2462	13.9	24	24	0.7
21-50	3256	32.3	115	139	3.9
16-20	936	37.5	53	192	5.4
11-15	2138	49.6	172	364	10.2
10	760	53.9	76	440	12.3
9	540	56.9	60	500	14.0
8	600	60.3	75	575	16.1
7	812	64.9	116	691	19.4
6	792	69.4	132	823	23.1
5	840	74.1	168	991	27.8
4	1080	80.2	270	1261	35.4
3	1044	86.1	348	1609	45.1
2	1012	91.8	506	2115	59.3
1	1451	100.0	1451	3566	100.0
	17,723				

parts. Each of these parts was needed to repair equipment that was deadlined for over 10 weeks. There is no doubt that NORS rates could have been significantly reduced had these parts been available.

Appendix Table B9 lists these 364 FSNs. Many of these FSNs could be stocked at the DSU with little noticeable effect on the total inventory investment. A few, of course, are exceptionally expensive lines that would not normally be available on an issue-to-customer basis. However, most of these are coded "recoverable" on the AMDF. Therefore they could be made available from the local DX facility on an exchange basis, assuming the repair capability of the DSU is sufficient to repair the unserviceables.

DSI

The DSI, defined in Chap. 2, is proposed as a measure of the ability of the first source of supply, the DSU, to meet requirements for readiness-affecting parts. No objective for this measure is suggested now, because a meaningful objective could only be developed from a complete historical record in which the asset balance on hand as of the deadline date would be compared with the list of deadlining parts. However, by measuring the DSI repeatedly over an extended time (at least 1 year), an appropriate objective should become apparent.

DX OPERATIONS

DX is the exchange of designated unserviceable but reparable components, modules, and major assemblies on a one-for-one basis for a serviceable item. The items controlled through the DX system constitute a large portion of the dollar value of the Army's secondary item inventory. The large investment involved and the relation to operational readiness have invited the attention of the Congress, General Accounting Office (GAO), and the Department of Defense on the problems associated with managing this program.[41] Currently emphasis is being placed by the Army on better control of DX items and better responsiveness to customer requirements. This is evidenced by such efforts as the Army Logistics Offensive Program, which includes improved DX as one of its primary goals. The official statement describing this objective is contained in reference 41. The purpose

of the circular is: "To provide guidance for a DA program to expand and standardize Direct Exchange (DX) procedures as a means for improving responsiveness to the customer, simplifying the logistic system and for improving visibility and management of repairable items."

The determination of which items qualify for DX is made by the item managers at the national inventory control points (NICPs) and broadcast to the field by letter and by coding the item in the AMDF as a nonexpendable recoverable item. Major commands designate which items meeting the DX criteria are to be included in their DX program. Local commanders also add and delete items.

DX System Concept

Figure 24 illustrates the DX system as it exists in field operations. Basically, there are three loops. The first and perhaps most critical loop is the exchange of unserviceable for serviceable items between the customer unit and his DSU. After inspection and determination of reparable status the item may either be repaired at the DSU or, if repairs are beyond it's capability, evacuated to the supporting GSU for repair or disposal action. Items requiring major overhaul, e.g., engines and transmissions, are forwarded to an appropriate depot, or if "washed-out" a new item is requisitioned. Of course, local variations are encountered in the system flow, e.g., a DSU if designated a DX Control Point may ship items directly to a depot within the theater or even back to CONUS. The level at which an item may be declared not economically repairable may also vary. The key point in all these transactions is the one-for-one accounting involved, one unserviceable turned-in for one serviceable issued.

Data Sources

DX information was obtained from DX stockage lists, stock accounting records, and registers at the units visited.

Each of the units with a DX supply function prepares and distributes to its customer units a DX list. These ranged in size from as few as 2 to over 350 FSNs. The lists also vary as to the amount of detail contained in them. Some simply list the FSN and nomenclature, whereas others contain details such as unit price, materiel category (MATCAT), ROs, and end item application. All the lists were supposedly

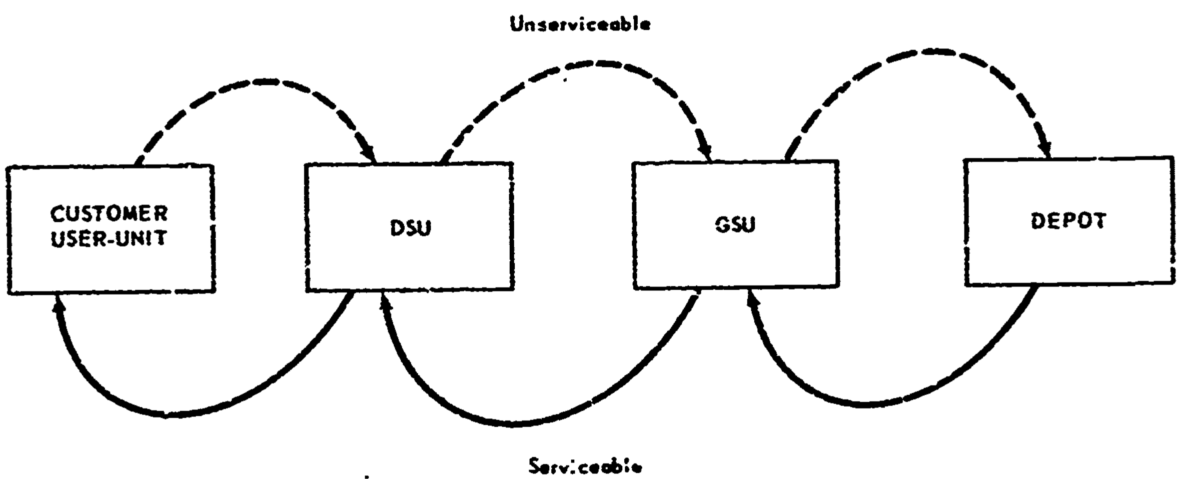

Fig. 24—Simplified Diagram of DX System

up to date but when compared to the stock accounting records in order to obtain the asset position the two sometimes could not be reconciled. In one case, where 300 major assembly and small component FSNs were listed, 29 FSNs could not be matched to a stock accounting card. Approximately 20 percent of the FSNs on the same list recorded no RO quantity. In another instance, 46 FSNs on the 125 line DX list could not be matched to the stock accounting records.

It was found that a few items on the DX lists were not reparable in a true sense, but the mechanism of DX was being used to control consumption. Two examples are spark plugs and batteries. Many such items turned in as unserviceable were later tested and found to be in serviceable condition, often requiring no more than cleaning or recharging prior to reissue.

DX Supply Activity

One of the USAREUR units, the 71st Maint Bn (nondivisional DS) maintained a daily transaction register of turn-ins and issues of small automotive components. It was possible to reconstruct the unit's DX supply activity for approximately a $3\frac{1}{2}$-month period using this register.

Table 41 presents a summary of the DX activity. The number of recorded demands (there is a possibility of demands for nonstocked items) amounted to 2408 during the period for an average of nearly 700 DX demands per month. No partial fills were recorded; a demand was completely filled for the quantity requested or a due-out established for the entire quantity. The controlled items, batteries and spark plugs, were not included in this analysis.

Table 41

DX SUPPLY ACTIVITY, 71ST MAINT BN (DS)

27 SEP 71 - 11 JAN 71

Activity	Number
Recorded demands	2408
Quantity turned in	3231
Quantity issued	2600
Number dues-out	530
Quantity due out	631

The data from the turn-in and issue register were used to develop DX fill and DX quantity fill rates. The DX fill rate, computed as described in Chap. 2, was 76 percent for the 3-month period examined. The DX quantity fill rate, which is the total DX fill quantity divided by the total DX quantity demanded, was computed to be 81 percent.

None of the other units visited maintained a register of this type, and the method used to post transactions to the stock accounting records precluded a comparable analysis.

DX Investment

An analysis was performed of the inventory value of DX items at three DSUs and one GSU. Using ROs when available, current AMDF unit price, stock accounting records to obtain the latest balance on hand (serviceables plus unserviceables), and the average balances of past entries, inventory values were calculated (see Table 42).

Although the data were not uniformly available for each of the calculations shown and the results are not completely consistent, two major observations can be made: there is considerable variation in list size, composition, and value; the absolute value of DX inventories is substantial, especially when the combined inventories of the hundreds of DX facilities worldwide are considered.

DX Commonality

The lists of seven different DX operations were compared to determine how many of the lines were common to more than one location. The source of the sample lists is shown in Table 43: three DSUs, three GSUs, and one installation-level operation. All but two of these units are located in USAREUR. The list sizes for those units also used in the dollar value analysis (Table 42) are a little larger because some lines were dropped because of lack of ROs and nonmatch to the stock accounting records. The DX lists used were those made available to customer units by the maintenance organization.

Of the total 1341 FSNs considered, and recognizing that some of the same FSNs appear on more than one DX list, the number of different (unique) FSNs reduces to 783. Table 44 indicates that commonality between more than two of the lists is rather low. Only 126 FSNs (16 percent) appear on three or more lists.

RAC

Table 42

DOLLAR VALUE OF RO AND STOCK ON HAND FOR DX LINES

Unit	FSNs	Dollar value: RO	Stock on hand: Most recent	Stock on hand: Average
71st Maint Bn (DS)				
Major assemblies	80	994,842	247,842	281,067
Small components	224	131,374	283,353	280,934
	304	1,126,216	531,195	562,001
123d Maint Bn (DS)				
Major assemblies	57	-[a]	0	0
Small components	79	28,418[b]	144,407	131,628
	136	28,418	144,407	131,628
703d Maint Bn (DS)				
Small components				
A Co	134	254,782	-[d]	-[d]
C Co	109	64,864	-[d]	-[d]
D Co	118	85,015	-[d]	-[d]
E Co	111	72,803	-[d]	-[d]
	134[c]	477,464		
42d HEM Co (GS)				
Major assemblies	70	-[a]	1,312,092	1,440,046
Small components	211	-[a]	266,873	214,885
	281		1,578,965	1,654,931

[a] RO not available.

[b] Based on original list of 125 FSNs.

[c] Unique FSNs.

[d] Stock accounting records not available.

Table 43

SOURCE OF DX LISTS USED IN COMMONALITY ANALYSIS

Unit	List size (FSNs)
71st Maint Bn (DS)	323
123d Maint Bn (DS)	196
703d Maint Bn (DS)	135
182d LEM Co (GS)	223
8905th Labor Service Co (GS)	292
249th Repair Parts Co (GS)[a]	54
Materiel Maintenance Division[a] (Installation level)	118

[a]Fort Bragg, N.C.

Table 44

DX LIST COMMONALITY ANALYSIS

Appearing on list of:	Unique FSNs	Percent
One unit	470	60
Two units	187	24
Three units	60	8
Four units	33	4
Five units	14	2
Six units	18	2
Seven units	1	<1
Total	783	100

This comparison highlights the degree to which DX lists vary as a function of local commander's option. Some variation is necessitated by differences in mission and mix of equipment supported, but the desirability of greater uniformity is recognized in the logistics improvement program where standardization of DX items is called for within commands to the maximum extent possible.[41]

The two performance goals advanced below, DX quantity fill rate and DX deadline index, are in consideration of the fact that DX items can and do play a major role in materiel readiness. Improved bookkeeping, perhaps under CS_3, may yield a firmer base for objectives. Nonetheless the establishment of interim goals is suggested.

DX Performance Measures

Three basic performance measures are proposed to assist the DSU/GSU commander in the management of his DX operation. One measure, DX fill rate, is computed in the same manner as the ASL fill rate described in Chap. 2. DX quantity fill rate is a slight variation in that it measures the absolute quantity of items demanded that are filled immediately. In addition to these two measures of supply effectiveness, the DX deadline index described below is offered as another method of helping the commander evaluate the overall efficacy of his DX operation.

DX Quantity Fill Rate. The DX quantity fill rate is that fraction of total quantity demanded for DX lines (for serviceable reparables) that are supplied on request. The formula for this measure is:

$$\frac{\text{DX fills (quantity)}}{\text{Total DX quantity demanded}} (100) = \%\ \text{DX quantity fill}$$

Demands for inexpensive lines required in sets, e.g., spark plugs, if included in DX for control purposes, would be excluded from the computation. However, the following specific types of lines normally required in sets would be included: tires, inner tubes, brake shoes, and similar lines. All set-type lines that are locally excluded would be listed by FSN and submitted when reporting DX measures.

Data sources include the DX stock accounting cards, DX issue, and turn-in registers and computer records under CS_3.

Based on the analysis of the 71st Maint Bn DX operation discussed earlier in this section, an objective of 75 percent DX quantity fill is

attainable. This rate of quantity fill is also supported by Tables B4 and B5, App B, which illustrate the fill rate for tech supply derived from SPSM output. Although tech supply and DX are different in concept and operation these tables do indicate that a 75 percent fill rate is realistic.

DX Deadline Index. This measure is defined as the fraction of total serial-numbered equipments deadlined for the customers of a DSU by one or more lines contained on the DSU DX list. The formula for computing this index is:

$$\frac{\text{Number of equipments deadlined by DX lines}}{\text{Total equipments deadlined}}(100) = \%\ \text{DX deadline}$$

This measure quantifies the influence of inadequate DX support on a user's deadline status. Aside from its absolute value, the growth or decline of this index is a valuable indicator of DX operations.

The source of data is the reverse side of DA Form 2406, "Materiel Readiness", which lists parts causing deadlines. The deadliners are compared with the current DX list to compute the index. The experience of DX personnel of the 71st Maint Bn indicates that an objective not to exceed 5 percent is feasible.

SUPPLY SYSTEM RESPONSE RATE

As explained in Chap. 2, the SSRR is a combined measure of the efficiency of the DSU itself and of the supply system's response to requirements that cannot be met by the DSU.

Definition and Formula for SSRR

The SSRR is the sum of fills provided immediately, outstanding backorder releases, and nonstockage dues-in receipts expressed as a percentage of cumulative commitments.

$$\frac{\text{Sum of fills provided during the period}}{\text{Sum of prior unfilled commitments and demands this period}}(100) = \text{SSRR}$$

The formula may be restated as:

$$\frac{\begin{array}{c}\text{Demands immediately}\\ \text{filled (this period)}\end{array} + \begin{array}{c}\text{backorders released*}\\ \text{(this period)}\end{array} + \begin{array}{c}\text{receipts of}\\ \text{dues-in*}\\ \text{(this period)}\end{array}}{\begin{array}{c}\text{Demands received}\\ \text{(this period)}\end{array} + \begin{array}{c}\text{open backorders}\\ \text{(beginning of period)}\end{array} + \begin{array}{c}\text{NSL dues-in}\\ \text{(beginning of}\\ \text{period)}\end{array}}(100) = \text{SSRR}$$

*Releases or receipts during this period, regardless of date of establishment of backorders or dues-in.

Data required to compute this measure should be currently available at every DSU. Demands immediately filled (this period) and demands received (this period) are used now - their quotient yields the tech supply fill rate. Backorders released and NSL receipts due in would undoubtedly be recorded, but in some DSUs a manual tabulation might be required. Open backorders and the NSL dues-in at the beginning of the period could be obtained from a manual count of cards in the dues-in file.

Development of an SSRR Objective

The suggested SSRR objective developed herein is based on 8 months' experience for an armored division. These data are listed in Table 45.

It is assumed that the sum of backorders released and receipts of NSL dues-in in any period is approximately equal to the number of newly established backorders and NSL dues-in during the same period. Hence no buildup (or decrease) in average unfilled commitments is experienced. Based on this assumption, it may be further assumed that the bulk of outstanding commitments at the beginning of each period (e.g., month) are carryovers from the preceding period and, to a progressively lesser degree, each of the periods preceding that. If this is the case the total number of dues-in at the beginning of any month will constitute all those established last month, some percentage of those established the month before, a lesser percentage of those established the month before that, etc. The precise assumptions made regarding these percentages appear in Table 46. These percentages are admittedly arbitrary but at the same time, are felt to be reasonable based on the experience of units in the field.

Inserting appropriate numbers into the SSRR formula described above will yield performance experience based on the statistics of Table 45 and the above assumptions:

$$\frac{7436 + (3054 + 1695) + 3150}{15,335 + 16,273}(100) = 49 \text{ percent}$$

To establish an objective for the SSRR, the objective for tech supply fill rate of 64 percent (from Chap. 3) is used. From Table 45, the average net requests received = 15,335. Sixty-four percent of these would be immediately filled, i.e., 9814 requisitions.

Table 45

DEMAND STATISTICS FOR AN ARMORED DIVISION, 1971

Month	Net[a] requests received	Demands immediately filled	Tech supply fill rate,%	Back-orders Established	NSL dues-in[b] Established
1	24,015	10,379	43	5,269	4,949
2	17,790	9,977	56	3,571	2,840
3	23,567	9,870	42	4,195	6,953
4	7,660	3,862	50	1,939	724
5	9,769	4,424	45	2,468	1,569
6	12,108	6,447	53	1,891	2,602
7	14,126	7,036	50	2,789	2,892
8	13,642	7,493	55	2,306	2,669
Totals	122,677	59,488		24,428	25,198
Averages	15,335	7,436	48	3,054	3,150

[a]Net requests = total requests - requests rejected.

[b]NSL dues-in established are assumed to be equivalent to demands not accommodated.

Table 46

ASSUMED DISTRIBUTION OF PRIOR COMMITMENTS

Month[a]	Commitments[b] still outstanding from that month	
	Percent assumed	Number, computed[c]
1	100	7,899
2	40	3,160
3	20	1,580
4	10	790
5	8	632
6	7	553
7	6	474
8	5	395
9	4	316
10	3	237
11	2	158
12	1	79
Total commitments, beginning of any month		16,273

[a]Month 1 is last month, month 2 the month before last, etc.

[b]Commitments generated each month include all backorders established and all NSL dues-in established, plus any requests accommodated but not immediately filled and for which no new backorders need be established (because estimated delivery date is prior to required date set by priority).

From Table 45:	avg backorder established/month	3,054
	avg fringe due-in established/month	+3,150
		6,204
	avg demands immediately filled/month	+7,436
		13,640
	avg net requests received/month	15,335
	less demands filled, backordered, due-in	-13,640
		1,695

Thus, commitments generated per month may be computed: 6204 + 1695 = 7899.

[c]Assumed percent multiplied by 7899.

Substituting 9814 for 7436 in the above computation yields an SSRR of 56 percent. Thus it is felt that 56 percent represents a meaningful and realistic objective for SSRR.

ASL DUES-IN OVER 180 DAYS

An ASL due-in is a requisition pending fill from a higher supply source. A measure developed to monitor the duration of dues-in at the DSU is "ASL dues-in over 180 days."

$$\frac{\text{Number of ASL dues-in over 180 days}}{\text{Total number of ASL dues-in}}(100) = \%\ \text{ASL dues-in over 180 days}$$

The date a requisition is forwarded by the DSU to the next higher supply echelon signals the beginning of the time span of the due-in. The time span ends on the date of formal recording of receipt of the materiel at the DSU. The duration of a due-in is clearly beyond the influence of a DSU commander and must be viewed as a function of overall supply system performance.

As shown in Fig. 7, Chap. 2, ASL dues-in over 180 days is related to zero balance with dues-out. If a suitable objective for ASL dues-in over 180 days is selected and met, zero balances with dues-out can be kept at an acceptable level at the DSU.

Table 47 was developed from data from the DSS USAREUR Performance Evaluation.[42] Of nearly 69,000 requisitions due in to DSUs in a year, sufficient detail was available to develop age distributions for approximately 16,000. Since the time span of dues-out from the NICP (see Table 47 footnotes) does not coincide with the time span of dues-in to the DSU, the distribution must be shifted forward (increased) by an amount equal to the average time from the NICP depots to the date receipt of materiel is recorded at the DSU (approximately 50 days). Similarly the 52,589 ASL requisitions due in at the DSU for which no dues-out had been established at the NICP were assumed to have been filled immediately from NICP assets and hence would encounter a delay equal to the OST from DSU to NICP back to DSU (approximately 57 days). Taking Table 47 and the above OSTs into account, a distribution of the ages of dues-in to the DSU was constructed (Table 48). The data of Table 48 are plotted in Fig. 25 and may be considered representative of performance attained

Table 47

AGE OF ASL DUES-OUT FROM NICPs,

YEAR ENDING 29 FEBRUARY 1972

Item	Duration of ASL dues-out from NICP, days									Total
	1-3	4-5	6-30	31-60	61-90	91-120	121-150	151-180	>180	
ASL requisitions due-out from NICP[a]	32	200	1255	1160	740	572	409	179	470	5,018
ASL dues-out released by NICP[b]	1021	830	4110	2081	1310	780	320	279	379	11,110
Total	1053	1030	5365	3241	2050	1352	729	458	850	16,128
"greater than" cumulative %	100.0	93.5	87.1	53.8	33.7	21.0	12.6	8.1	5.3	
ASL dues-in at DSU for which no dues-out established at NICP[c]										52,689
Total ASL dues-in at DSU										68,817

[a]Based on elapsed days from date of document order number (DON) to 29 Feb 72.

[b]Based on elapsed days from DON date to date of due-out release at NICP. Includes 4682 dues-out released for which age at release could not be determined. The assumption was made that the 4682 releases were distributed in the same proportion as the 6428 releases for which ages were available.

[c]These requisitions, forwarded from the DSU, are assumed to have received immediate fill from NICPs.

Table 48

AGE OF ASL DUES-IN TO DSUs

Item	Duration of ASL dues-in, days							
	>0	>30	>80	>110	>140	>170	>200	>230
No. of ASL dues-in	68,817	66,752	8680	5439	3389	2037	1308	840
Cumulative %	100.0	97.0	31.5	18.9	11.0	6.1	3.1	1.2

under current Army supply policies. The objective for zero balances with dues-out (Chap. 3) for the current 6-3 breadth policy is 4.7 percent. Accordingly an objective for dues-in over 180 days may be chosen from Fig. 25 and be consonant with the objective for zero balance with dues-out. An objective of 5 percent or less was chosen.

NSL DUES-IN OVER 180 DAYS

Like ASL, NSL dues-in over 180 days measures supply system responsiveness beyond the DSU commander's ability to influence. It is related to SSRR.

$$\frac{\text{Number of non-ASL dues-in over 180 days}}{\text{Total number of non-ASL dues-in}}(100) = \%\ \text{NSL dues-in over 180 days}$$

The DSS USAREUR Performance Evaluation[42] provides data relative to the duration of NSL dues-in (Table 49). As with ASL dues-in, the distributions must be shifted forward (increased) by an amount equal to the average OST (50 days is used as an approximation) to relate dues-out from the NICPs to dues-in to the DSUs. The 66,345 dues-in at the DSU for which no dues-out have been established at the NICPs are assumed to have been filled immediately from depot stocks and would have been due in for a length of time equal to the average OST from DSU to NICP and back to DSU, approximately 55 days.

Based on Table 49 and the above OSTs, a distribution of due-in ages to the DSU was developed. This is shown in Table 50 and is plotted in Fig. 25 with the ASL dues-in distribution.

Although no empirical relation has been developed between NSL dues-in greater than 180 days and the SSRR, the derivation of the latter measure implies a close relation. The SSRR objective is based on a

Table 49

AGE OF NSL DUES-OUT FROM NICPs,

YEAR ENDING 29 FEBRUARY 1972

Item	Duration of NSL dues-out, days									Total
	1-3	4-5	6-30	31-60	61-90	91-120	121-150	151-180	>180	
NSL requisitions due-out from NICP[a]	35	234	1921	2063	1281	854	561	275	464	7,688
NSL dues-out released by NICP[b]	1138	958	4151	2498	1274	739	324	178	168	11,428
Total	1173	1192	6072	4561	2555	1593	885	453	632	19,116
"greater than" cumulative %	100.0	93.9	87.6	55.9	32.0	18.6	10.3	5.7	3.3	
NSL dues-in at DSU for which no dues-out established at NICP[c]										66,345
Total NSL dues-in at DSU										85,461

[a]Based on elapsed days from date of DON to 29 Feb 72.

[b]Based on elapsed days from DON date to date of due-out release at NICP. Includes 5152 dues-out released for which age at release could not be determined. The assumption was made that the 5152 releases were distributed in the same proportion as the 6276 releases for which ages were available.

[c]These requisitions, forwarded from the DSU, are assumed to have received immediate fill from NICPs.

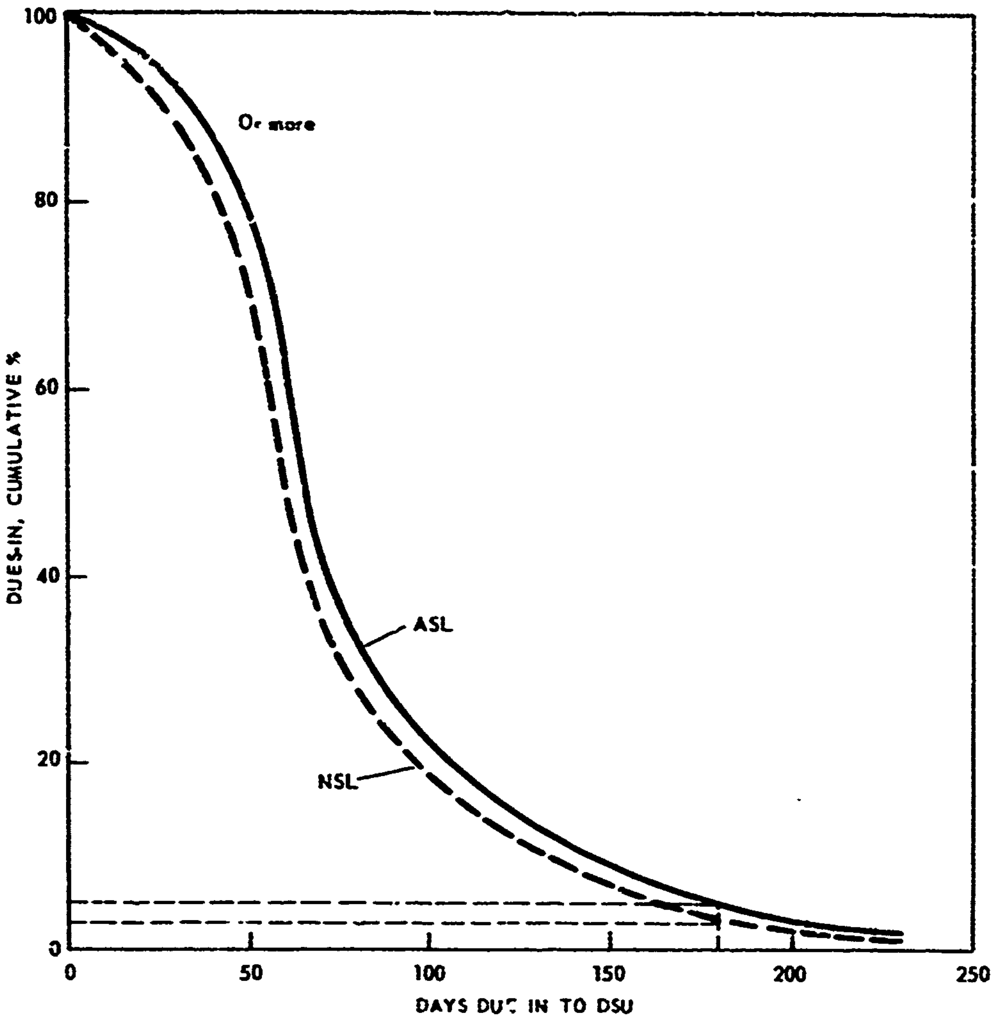

Fig. 25—Age of ASL and NSL Dues-in to European DSUs

Table 50

AGE OF NSL DUES-IN TO DSUs

Item	Duration of NSL dues-in, days							
	>0	>30	>80	>110	>140	>170	>200	>230
No. of NSL dues-in	85,461	81,188	10,679	6118	3563	1970	1085	632
Cumulative %	100.0	95.0	25.1	15.6	8.5	4.3	2.0	0.7

tech supply fill rate of 64 percent. The NSL curve shown in Fig. 25 is used as the basis for selecting the objective of 3 percent or less for this measure.

INDICATORS OF EXCESS ASSETS

Deletions from the ASL are perhaps the most important contributors to the accumulation of excesses at the DSU. Other causes include turn-in of nonstocked items, cancellation of requests for nonstocked items, and recomputation of the RO. Excesses are to be disposed of in accordance with AR 755-2.[24] Unserviceable or nonrecoverable expendables are excluded from excess tallies.

Assets for nonstocked items may be retained up to 60 days from the date of receipt. However, disposition action may be initiated at any time an item becomes excess provided the excess is valued at $20 or more for CONUS installations, $50 or more for oversea installations, and $10 or more for any DSU.

ASL excesses are further defined by echelon, stockage policy, and arbitrary quantities of allowable excesses as follows:

1. Installation, items falling under EIP: all assets in excess of the RO quantity plus 360 days' worth of expected consumption.

2. Installation, items falling under EOQ policy: all assets in excess of twice the RO quantity.

3. DSU, EOQ: all assets in excess of twice the RO quantity.

4. DSU, fixed stockage level based on days of supply: all assets in excess of the RO quantity plus 90 days' worth of expected consumption.

The Ratio of SOH to RO

The RO represents the greatest quantity of supplies authorized to be on hand and/or due in at any one time in order to sustain current DSU operations.[8]

SOH to RO is the quantity or dollar value of current SOH for ASL items divided by the quantity or dollar value of the RO, and is determined by:

$$\frac{SOH}{RO}(100) = \%\ SOH \text{ to } RO$$

The measure is designed to apprise commanders of potential shortages or costly overages in assets.

In developing an objective for this measure, inventory theory practiced by the Army offers at least two approaches. Either the theoretical average SOH or the theoretical maximum SOH may be used as a yardstick against which to compare actual SOH values. The theoretical average SOH equals one-half OL stocks plus SL stocks. The theoretical maximum SOH equals OL plus SL stocks.[43] It is extremely unlikely that each line on the ASL will have the maximum SOH, but it is felt that provision must be made for that possibility. Hence, although the theoretical or computed average SOH is discussed below, the computed maximum SOH is used as the basis for developing an objective.

The data for developing SOH and RO values are readily obtainable from the DSU's MIR or stock status report, each of which is prepared periodically by computer. Table 51 illustrates the computation of this measure for VII Corps units, USAREUR, using one year's data ending in December 1971. The variable RO was developed using the EOQ OL, a 15 day SL and a 45 day OST.

The theoretical maximum SOH presumes that the entire OL and SL are on hand for each FSN on the ASL. The maximum SOH, as a percentage of the RO varies from 49.7 to 70.0 percent. These values are used as the basis for developing an SOH/RO objective. Their statistical characteristics are:

Number of variates	25
Arithmetic mean	60.03
Standard deviation (σ)	5.04
Median	60.1
Range	20.3
Mean + 3σ	75.15

In such a normal distribution, 99.73 percent of the maximum SOH/RO observations would be included within three standard deviations of the mean. Accordingly, the objective has been set at the upper limit of

Table 51

SOH TO RO VALUES FOR VII CORPS UNITS

Unit	Variable RO dollars	Average SOH, dollars ($\frac{1}{2}$ OL + SL)	Max SOH, dollars (OL + SL)	Max SOH/RO, % (objective)	Actual SOH, dollars[a]	Actual SOH/RO, %
A/703 Maint Bn	322,405	116,206	187,414	58.1	493,596	153.1[b]
B/703 Maint Bn	16,872	5,644	8,495	50.3	247.707	1468.2[b]
A/123 Maint Bn	460,229	163,169	259,392	56.4	748,970	162.7[b]
C/1 Maint Bn	75,053	29,200	50,074	66.7	49,599	66.1
B/1 Maint Bn	40,062	16,024	28,040	70.0	36,095	90.1[b]
A/1 Maint Bn	157,316	59,172	98,857	62.8	93,315	59.3
B/71 Maint Bn	123,134	44,762	72,719	59.1	106,670	86.6[b]
C/71 Maint Bn	101,849	37.851	62,628	61.5	73,879	72.5
A/71 Maint Bn	173,681	62,401	100,362	57.8	141,251	81.3[b]
572 HEM Co	136,794	52,542	89,228	65.2	97,929	71.6
48 Acft Maint Co	27,428	10,632	18,182	66.3	21,143	77.1[b]
124 HEM Co	123,424	42,740	66,510	53.9	95,371	77.3[b]
903 HEM Co	39,109	14,465	23,841	61.0	62,947	161.0
78 LEM Co	3,478	1,366	2,360	67.9	2,180	62.7
182 LEM Co	45,336	15,668	24,335	53.7	33,023	72.8
116 Ord Det	15,356	5,103	7,630	49.7	13,027	84.8[b]
42 HEM Co	36,597	13,534	22,302	60.9	48,838	133.4[b]
66 HEM Co	32,459	11,871	19,383	59.7	81,973	252.5[b]
8904 LS Co	160,203	59,904	99,613	62.2	101,538	63.4
8902 LS Co	136,337	51,260	85,611	62.8	82,254	60.3
8905 LS Co	56,489	20,729	33,942	60.1	39,895	70.6
A/35 S&S Bn	274,978	103,845	174,047	63.3	274,916	100.0[b]
B/35 S&S Bn	410,687	146,886	235,315	57.3	289,137	70.4
A/95 S&S Bn	405,012	144,340	230,514	56.9	167,850	41.4
B/95 S&S Bn	503,957	179,923	287,790	57.1	287,375	57.0

[a]Demand-supported lines, as of December 1971.
[b]SOH/RO > objective.

75.15 percent. The likelihood of obtaining a computed SOH/RO value greater than three standard deviations from the mean by chance is minimized within the practical limits of the distribution.

Acquisition Value of Excesses

For those excesses that may be identified by a valid FSN, the acquisition value is the item unit price multiplied by the quantity in excess as defined above. This measure is computed for all excess assets, regardless of how they may arise.

For ASL lines, a comparison of the quantity on hand as reported on periodic stock status reports to the RO quantity will reveal excess quantities, if any. For HSL lines, any quantity on hand is considered excess. These may be identified either from machine records or via manual count. The unit price may be found in the microfilmed AMDF.

Objective. The assumption is made that the dollar value of excess assets on hand at any time should not exceed the dollar value of the average SOH ($\frac{1}{2}$ OL + SL) for ASL lines. The actual dollar values of SOH will vary by time period and by unit but should not generally exceed the following:

1.	DS maintenance battalions (HQ and A Cos)	\$140,000
2.	DS maintenance battalions (forward Cos)	32,000
3.	GS maintenance companies	18,000
4.	Supply and service companies	140,000

These objectives are based on the values of Table 52 where average SOH was computed for similar units. For example, the average SOH for A/703 and A/123 was used to derive the excess objectives for DS maintenance battalions (\$140,000). Table 52 was developed from MIR statistics dated December 1971 for selected VII Corps units, USAREUR.

Unidentifiable Excesses

Although previous measure dealt with excesses that could be identified and priced out by way of the AMDF, field observation reveals that many excesses are unidentifiable and hence cannot be reported in terms of acquisition value. These excesses result from turn-ins and cancellations of nonstocked lines that cannot be identified by valid FSN or part number. The measure that indicates the magnitude of such excesses is restricted to the number and quantities of such parts and maintenance-related lines that are excess. Those numbers will be obtained via a physical count.

Objective. By regulation, AR 710-2,[8] unidentifiable assets are considered excess. Therefore, DSUs should have no more than a minimal amount on hand at any time. An objective of 10 lines for a quantity of no greater than 100 items is proposed.

Excesses, identifiable or unidentifiable, contribute materially to on-hand inventory investment, weight, and cube and thereby are costly in terms of storage cost outlay and potential impairment to the DSU's mobility. The contribution of such excesses to the tech supply fill rate is probably small. NSL assets, in particular, all of which may be classed as excess, were shown in Chap. 3 to have little influence on the tech supply fill rate statistic.

MEASURES OF PROCESSING TIME

Two segments of OST, measurable at the DSU, both of which are within the DSU commander's sphere of influence, are identified as request processing time and receipt processing time. These are discussed below:

Request Processing Time

This measure is defined as the number of days from the date a user request is received at the supply point to the date of the materiel release order (MRO). In the case of an out-of-stock position, request processing time would be the elapsed time from request arrival (presuming that date to be routinely stamped on back of incoming requests) to the assignment of a DON by the supply point. The assignment of the DON would signal completed processing of the request at the supply point and the determination that no stocks are on hand for the line requested. This measure of the first segment of the OST cycle does not come under maximum OST allowances specified under the Military Standard Requisitioning and Issue Procedure (MILSTRIP).[20]

Estimates of a DSU's processing time could be made from periodic checks, based on a sampling of user requests with date received at the DSU stamped on the reverse side (at one time performed on a regular basis by DSU personnel). The user RON (request order number) and the user unit identification code (UIC) would have to be noted on each request so as to be able to identify the date of the particular request from MRO listings.

Table 52

DEVELOPMENT OF AVERAGE SOH STATISTICS FOR VALUATION OF EXCESSES

Unit	Dollar value, annual demand quantity	Dollar value, 15-day SL	Dollar value of variable OL	Average SOH, dollars $\frac{1}{2}$ OL + SL
A/703 Maint Bn	1,094,777	44,997	142,417	116,206
B/703 Maint Bn	67,944	2,793	5,702	5,644
A/123 Maint Bn	1,628,791	66,946	192,446	163,169
C/1 Maint Bn	202,576	8,326	41,748	29,200
B/1 Maint Bn	97,495	4,007	24,033	16,024
A/1 Maint Bn	474,109	19,487	79,370	59,172
B/71 Maint Bn	408,866	16,805	55,914	44,762
C/71 Maint Bn	318,086	13,074	49,554	37,851
A/71 Maint Bn	594,620	24,440	75,922	62,401
572 HEM Co	385,767	15,856	73,372	52,542
48 Acft Maint Co	74,985	3,082	15,100	10,632
124 HEM Co	461,569	18,971	47,539	42,740
903 HEM Co	123,820	5,089	18,752	14,465
78 LEM Co	9,060	372	1,988	1,366
182 LEM Co	170,325	7,001	17,334	15,668
116 Ord Det	62,664	2,576	5,054	5,103
42 HEM Co	115,932	4,765	17,537	13,534
66 HEM Co	106,050	4,359	15,024	11,871
8904 LS Co	491,378	20,196	79,417	59,904
8902 LS Co	411,391	16,909	68,702	51,260
8905 LS Co	182,859	7,516	26,426	20,729
A/35 S&S Bn	818,544	33,643	140,404	103,845
B/35 S&S Bn	1,422,264	58,457	176,858	146,886
A/95 S&S Bn	1,415,179	58,166	172,348	144,340
B/95 S&S Bn	1,753,108	72,055	215,735	179,923

Empirical data for manual operations indicate that 50 percent of requests are processed in 4 days and 75 percent in 8 days.[44] The processing time for automated systems is predicated on the frequency of computer cycles. Assuming two cycles per week, an objective of 3 days is proposed for automated systems. A suitable objective for DSUs on manual systems is 4 days.

Receipt Processing Time

This measure defines the elapsed time from receipt of requisitioned materiel at a supply point until receipt is posted to accountable records. For units under DSS the calculation of this measure is simplified. For such units the receipt date of materiel at the DSU is recorded on in transit data cards. The date of posting to accountable records is the date the MIR is updated and is contained on receipt detail cards. For manual systems the receipt date is recorded on DD Form 1348-1, DOD Single Line Item Release/Receipt Document.[20] The posting date is the date assets are picked up on the stock accounting record, DA 1296.[8]

Receipt processing time is being monitored closely under the DSS. Statistics for this element of OST for USAREUR show an average of 7.6 days (ASL requisitions, less backorders) for the year ending 29 Feb 1972. The distribution of receipt processing times for nearly 25,000 USAREUR receipts is shown in Fig. 26. The average receipt processing time for DSUs in Korea under DSS is 7.3 days.[45]

Objectives for this measure already exist. AR 725-50[20] indicates a 2-day standard. DSS standards for Europe and Korea are set at 3 days. As noted above, experience under DSS shows both of those standards to be virtually unattainable for the bulk of receipts at DSU level. Receipt processing time under DSS, like request processing time, is tied to the frequency of computer cycles. In recognition of this fact and considering the distribution in Fig. 26 it would be logical to select an objective in keeping with reality, but at the same time not impose the DSS averages, which appear excessive for such an activity. Therefore, an objective of 5 days or less is advanced for this segment of OST.

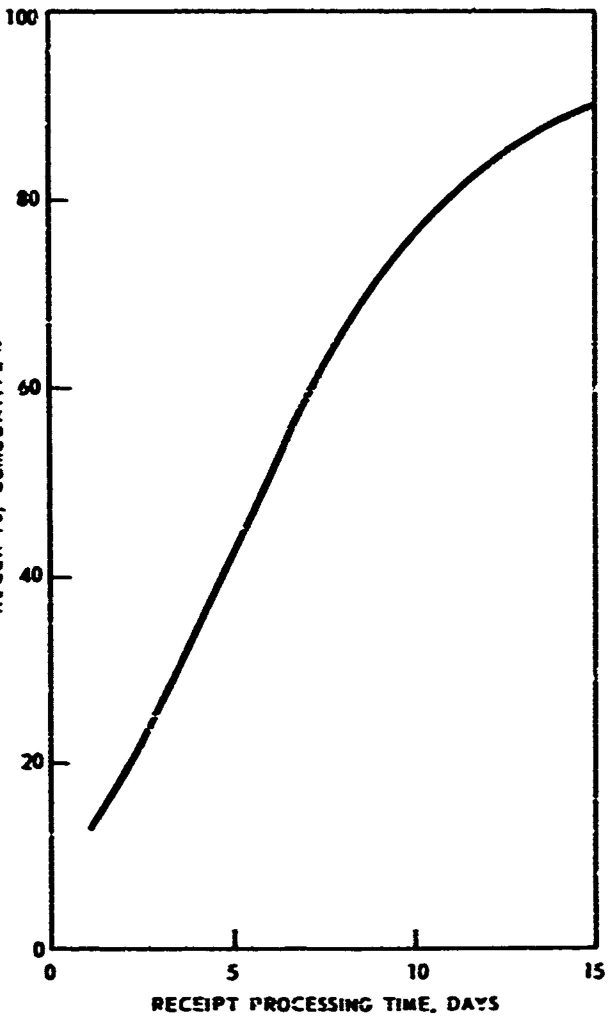

Fig. 26—Distribution of Receipt Processing Times for USAREUR DSUs, March 1971–February 1972

SUMMARY

The measures discussed in this chapter supplement the major policy-related measures of Chap. 3. Table 53 briefly summarizes the importance of the various measures and the objective selected for each. Several objectives are based on knowledge of current DSU performance.

Table 53

SUMMARY OF ADDITIONAL SUPPLY PERFORMANCE MEASURES AND OBJECTIVES

Performance measure	Importance of this measure	Suggested objective	Basis for selecting this objective
ASL mobility index	Primary measure of load carrying capability of the DSU	50%	SPSM,[a] current SOH
DSI	Considers deadlining parts which directly affect NORS	---[b]	Empirical data
DX (quantity) fill rate	Measures customer DX fill on demand; directly affects NORS	75%	Empirical data
DX deadline index	Specifies DX contribution to deadlined equipment; directly affects NORS	<5%	One unit's experience in using the measure
SSRR	Measures overall system performance; directly influences NORS	56%	SPSM, SCM,[a] empirical data
ASL dues-in over 180 days	Monitors age of ASL dues-in	<5%	Empirical data
NSL dues-in over 180 days	Monitors age of NSL dues-in	<3%	Empirical data
SOH/RO	Alerts DSU to excesses	<75%	Empirical data
Acquisition value of excesses	Aggregate measure of value of excesses	<$140,000[c]	Empirical data
Unidentifiable excesses	Measures magnitude of excesses that cannot be identified	<10 lines <100 items	Subjective
Request processing time •Automated •Manual	First segment of OST cycle	 <3 days <4 days	Empirical data
Receipt processing time	Final segment of OST cycle; controllable at DSU	<5 days	Empirical data

[a] In each instance, the SCM and SPSM were used with empirical data.

[b] A more complete historical record is required before an objective can be rationalized.

[c] DS maintenance battalions (Hq and A Co). Objectives for other DS/GS units may be found in Chap. 4 discussion.

Chapter 5

MAINTENANCE PERFORMANCE MEASURES

BACKGROUND

This chapter explores the relation among maintenance, the availability of repair parts, and unit performance. In the case of support units, performance is judged from the standpoint of the maintenance battalion commander as it applies to his mission of supporting customer units. The level of maintenance addressed includes DS and GS maintenance, as defined in Army regulations[9] and Chap. 2 of this report. The relation between the support function and customer performance as reflected by OR rates is explored as one method of gauging a maintenance unit's effectiveness. Primary emphasis is placed on the analysis of the repair cycle time and the implications of such factors as recorded maintenance man-hours, work backlog, and manpower utilization. Inconsistencies in repair cycle times and a failure to prove a positive statistical correlation between related maintenance measures preclude development of universally applicable maintenance performance objectives. However, the impact of maintenance on operational readiness requires the establishment of certain quantitative goals. These are suggested later in the chapter as potential management aids to the local commander to assist him in the allocation of his maintenance resources.

Previous RAC research in the area of maintenance and materiel readiness includes studies concerned with the economics of maintenance, overhaul policies, and requirements and analyses of effective life of tactical, support, and combat vehicles. Of particular interest are two documents prepared for the Brown Board.[1,46]

Other work in the area of maintenance performance includes the 1968 Stanford Research Institute report[47] that proposed various supply and maintenance performance measures along with a companion reporting system.

Certain maintenance performance data are currently reported under The Army Maintenance Management System (TAMMS).[48] For selected items of equipment, information pertaining to backlog status and man-hour and workload accounting, plus input to the NORS and NORM reports, is forwarded to LDC, Lexington, Ky. The Hi-5 Report generated by this activity summarized these data by type and model of equipment for both CONUS and the oversea theaters. More recently the Army has published the mean turnaround times (TATs) by type and model of equipment for days in transit, days waiting repair, and days in shop. These support maintenance times as reported under TAMMS are published in AR 750-1[9] and are discussed later.

The mission of a DSU as defined in Chap. 2 is divided into two general functions, supply and maintenance. This section addresses those areas of maintenance affecting the primary goal of the support unit - service to the customer. As outlined in Fig. 7, five main functions are associated with support maintenance. These are:

1. Providing support maintenance to customer units. In essence, this involves the repair of end items or components and/or replacement of components beyond the maintenance capability of the organizational unit. In some cases the support facility is called on to handle an overflow of work and accepts lower echelon jobs in order to reduce equipment downtime.

2. DX maintenance is the inspection, necessary repair, and return to the supply system of reparable items designated DX. Generally, DX items are components such as carburetors, starters, distributors, generators, engines, transmissions, etc, that are too complex to repair on the spot or require special test equipment, tools, skills, or repair kits not available at organizational level. The supply aspects of DX are discussed in Chap. 4.

3. Modification work order (MWO) installation is the modification or alteration of equipment in the field in order to incorporate the

latest engineering and safety features. In many cases this involves the installation of special MWO kits.

4. Fabrication and cannibalization. Fabrication involves the manufacture of items not usually available through regular supply channels. Cannibalization is the removal of serviceable items from an unserviceable end item in order to restore another similar equipment to service. Although these two activities fall under the purview of maintenance they are in fact supply functions.

5. A maintenance float is an end item or major assembly held at support level to replace similar unserviceable items that cannot be immediately repaired and returned to service. The term maintenance float includes both OR float and repair cycle float.

Topics discussed in this chapter include the sources of data, statistical tests applied to these data, an analysis of the repair cycle as reflected in TAT, the impact of parts shortages, utilization of maintenance personnel, maintenance floats, and suggested performance objectives.

DATA SOURCES

Data used in this analysis of maintenance performance were gathered in CONUS and in USAREUR. In November 1971 the RAC team visiting Ft Hood, Tex., obtained maintenance information from the 124th Maint Bn (DS) of the 2d Armd Div, plus GS data from the 190th HEM. USAREUR units visited in January 1972 included the 123rd Maint Bn (DS) of the 1st Armd Div, the 182d LEM Co, 42d HEM Co, and two elements of the 6930th Civil. Labor Gp. A complete list identifying the data sources and the units supported is shown in Table 54. The primary source of data from each of the maintenance units consisted of the Maintenance Request Register (DA Form 2405). This register, commonly referred to as the "job order register," is the basic source document used in all the TAT and man-hour analyses described in this section. Table 55 lists the volume of job order data obtained from each of the units constituting the data base.

In addition to the job order register the 124th Maint Bn, Ft Hood, Tex., maintained a backlog status report, which was used for the backlog analysis presented in this chapter.

Table 54

DATA SOURCES USED IN MAINTENANCE ANALYSIS

Location	Support unit	Units supported
Ft Hood, Tex	124th Maint Bn (DS) A, B, C, and E Cos	2d Armd Div
	169th Maint Bn (GS) 190th HEM Co	2d Armd Div 1st Cav Div (TRICAP)
USAREUR	123d Maint Bn (DS) A, B, and C Cos	1st Armd Div
	303d Maint Bn (GS) 182d LEM Co 42d HEM Co	1st Armd Div 3d Inf Div (Mech) Non-div Units
	6930th Civ. Labor Gp 8902d LS Co (DS)[a] 8905th LS Co (GS)[a]	VII Corps Units

[a]Labor Service.

Table 55

VOLUME OF MAINTENANCE DATA

Unit	Number of job orders
A/123	10,130
B/123	1,144
C/123	1,200
A/124	7,853
B/124	1,426
C/124	634
E/124	860
42d HEM	2,113
182d LEM	8,718
190th HEM	3,526
8902d LS	4,920
8905th LS	14,491[a]
Total	57,015

[a]Includes 3502 job orders without recorded man-hours.

SUPPORT NORM

As discussed in Chap. 2 of this report, the primary measure of a DSU's maintenance effectiveness is the support NORM rate of its customer units. The importance of operational readiness and the impact of the supply and maintenance functions of the DSU on readiness has previously been emphasized. The NORM rate is currently reported for specific equipment types and individual units to LDC which publishes a quarterly report listing the OR, NORS, and NORM rates for organizational and support levels.[11] These reports were used to compile Table 56 which gives the support NORM rate for six combat divisions for seven quarterly increments.

Table 56

SUPPORT NORM RATES,

SIX DIVISIONS, SEVEN QUARTERS

Quarter	Division					
	A	B	C	D	E	F
1	1.3	1.8	2.5	1.6	1.8	1.4
2	1.3	2.0	3.0	1.3	2.4	1.7
3	1.4	1.9	2.3	1.7	1.3	1.4
4	1.1	1.6	1.7	1.8	1.6	1.7
5	--[a]	1.6	1.8	2.2	1.5	1.5
6	1.6	3.0	2.4	2.2	1.9	1.7
7	2.5	--[a]	2.8	1.8	1.8	1.9

[a]Data not available.

Note that the NORM rates listed for the approximate two year period are rather stable. The NORM ranges from a low of 1.1 to 3.0 percent with an overall average for all divisions of 1.8 percent. Based on these data a performance objective of 2 percent or less is proposed.

MAINTENANCE TAT

Four time measurements are obtainable from the job order register; three pertain to equipment TAT, and the other shows maintenance manhours expended.

TAT is the total elapsed days from receipt of the job order request at the maintenance shop to completion of the job and is composed of two separate elements extracted from the job order register.

1. Time awaiting shop - Elapsed days between the time the job order request is received at the maintenance facility and the time work begins.

2. Time in shop - Elapsed days between the time work commences and the time the job is completed.

The sum of these two segments constitutes total TAT, i.e., the elapsed days between receipt of the job order at the maintenance shop and the completion date.

As a measure of the maintenance unit's performance and effectiveness it is felt that TAT is the ultimate performance measure. As evidenced by Fig. 7, other measures and maintenance statistics are considered subordinate to TAT. Of the primary maintenance functions—maintenance for customer, DX maintenance, MWO installations, and fabrication and cannibalization, the two most important, i.e., customer and DX maintenance, are most directly affected by TAT. These two functions in turn have a direct effect on the NORM rate, a primary measure of DSU mission accomplishment.

Table 57 gives total maintenance TAT (time awaiting shop plus time in shop) computed for each of the DSUs/GSUs in the sample. These times were developed by equipment categories because of the composition of the job order register. The registers are maintained by maintenance sections as listed in the table, i.e., armament, artillery, automotive, etc. Primary emphasis is placed on certain major equipment categories: automotive, avaiation, DX, electronic, and engineer.

The distributions from which Table 57 was developed show a skewed curve. The absence of a normal distribution results in a wide variation between the mean, the median, and the mode (the most common value), as illustrated by the table. The heavy influence of the extended time job orders is reflected in the relatively high mean times evident for various equipment types. When compared to the median and modal values, the significance of the mean as a true indicator of performance appears questionable. For example, the mean TATs for automotive

Table 57

MAINTENANCE TURNAROUND TIME

Equipment	Unit	Location	Echelon	Job orders	TAT, days		
					Mean	Median	Mode
Armament	A/123	USAREUR	DS	159	44	10	9
	C/123	USAREUR	DS	421	25	1	1
	42d HEM	USAREUR	GS	340	21	7	1
Artillery	A/123	USAREUR	DS	370	25	6	6
Automotive	A/123	USAREUR	DS	1713	28	12	1
	C/123	USAREUR	DS	219	37	17	1
	A/124	Ft Hood	DS	1068	20	7	1
	C/124	Ft Hood	DS	366	29	20	1
	E/124	Ft Hood	DS	225	23	8	1
	8902d LS	USAREUR	DS	2441	16	3	1
	42d HEM	USAREUR	GS	163	13	6	1
	190th HEM	Ft Hood	GS	580	28	14	7
	8905th LS	USAREUR	GS	249	12	6	3
Aviation	B/123	USAREUR	DS	1144	17	5	1
	B/124	Ft Hood	DS	1426	16	9	1
Calibration	A/123	USAREUR	DS	127	43	24	33
	190th HEM	Ft Hood	GS	161	28	18	18
	8905th LS	USAREUR	GS	278	24	25	1
Chemical	A/123	USAREUR	DS	244	73	41	1
	182d LEM	USAREUR	GS	564	11	4	2
DX Component Repair	42d HEM	USAREUR	GS	1531	30	17	2
	8905th LS	USAREUR	GS	622	16	8	5
				3502[a]	19	9	3

[a]One portion of the 8905th LS Co DX component job order register contained 3502 job orders with only the receipt and completion dates recorded, which required separate processing.

Table 57 (continued)

Equipment	Unit	Location	Echelon	Job orders	TAT, days		
					Mean	Median	Mode
Electronic	C/123	USAREUR	DS	438	25	10	1
	A/124	Ft Hood	DS	5518	23	8	1
	C/124	Ft Hood	DS	268	15	6	2
	E/124	Ft Hood	DS	605	30	12	2
	182d LEM	USAREUR	GS	5519	14	5	2
	8905th LS	USAREUR	GS	3910	16	6	1
Engineer	A/123	USAREUR	DS	351	29	8	1
	A/124	Ft Hood	DS	266	79	23	1
	42d HEM	USAREUR	GS	79	13	7	5
	182d LEM	USAREUR	GS	1585	8	1	1
	190th HEM	Ft Hood	GS	203	46	23	8
	8905th LS	USAREUR	GS	1437	27	6	4
Fuel and Electrical	A/123	USAREUR	DS	2582	16	7	5
	190th HEM	Ft Hood	GS	571	21	12	7
	8905th LS	USAREUR	GS	3256	12	7	2
Instruments	A/123	USAREUR	DS	1039	26	7	1
	190th HEM	Ft Hood	GS	667	35	23	2
Quartermaster	182d LEM	USAREUR	GS	545	16	4	1
Service shop	A/123	USAREUR	DS	1949	30	11	1
	C/123	USAREUR	DS	122	65	30	1
	A/124	Ft Hood	DS	1001	10	4	1
	8902d LS	USAREUR	DS	1837	19	8	1
	182d LEM	USAREUR	GS	505	8	3	2
	190th HEM	Ft Hood	GS	1016	14	8	1
	8905th LS	USAREUR	GS	466	24	15	2
Small arms	A/123	USAREUR	DS	1596	17	1	1
	8902d LS	USAREUR	DS	642	4	2	1
	190th HEM	Ft Hood	GS	323	19	17	3
Test equipment (electrical)	8905th LS	USAREUR	GS	[illegible]	14	5	1

equipment (both wheeled and tracked) vary for DSUs from a low of 16 days to a high of 37 days. Median DS times ranged from 7 to 20 days, whereas the mode was consistently 1 day. The mean values for the three GSUs range from 12 to 28 days and the median from 6 to 14 days. Modal values vary from 1 to 7 days.

The range of values between units for major equipment categories ran from 21 to 44 days mean TAT for armament, 14 to 30 days for electronic, 8 to 79 days for engineer and, 8 to 65 days for service shop.

A computer program was developed to produce cumulative frequency distributions for each of the equipment categories (each of the three TAT elements is shown) both for individual units and on a combined DS and GS basis. A complete set of these distributions is presented in App C.

The combined cumulative distributions for DSUs and GSUs for armament, aviation, automotive, DX components, electronics, engineer, and small arms are presented in Figs. 27 to 33, .plotted on semi-logarithmic paper .

The cumulative distribution curves developed indiate a nonnormal distribution caused by the relatively rapid TAT experienced by the first 50 to 60 percent of the jobs while the remaining jobs constitute a long tail stretching out to as long as 400 days.

For armament (Fig. 27) the two DSUs completed approximately 66 percent of their jobs within 10 days, and the GSUs completed 58 percent within the same time. The two aviation DSUs (Fig. 28) completed 60 percent of the jobs within 10 days and 90 percent within 35 days. Automotive TAT is shown in Fig. 29; GS TAT is 10 days for 53 percent, DS is 10 days for 56 percent. GSUs' DX component repair performance is shown in Fig. 30; their combined TAT is 43 percent completion with 10 days. Repair performance for electronics, engineer, and small arms (shown in Figs. 31 to 33) displays the same tendency with an average of one-half the job orders completed within 10 days and long wait for the remaining jobs.

The reason for the protracted TAT is subject to conjecture. Possible causes, however, are rather limited; either the equipment is part of a work backlog caused by overloaded facilities within the shop, or much of the repair cycle is in reality consumed awaiting the arrival

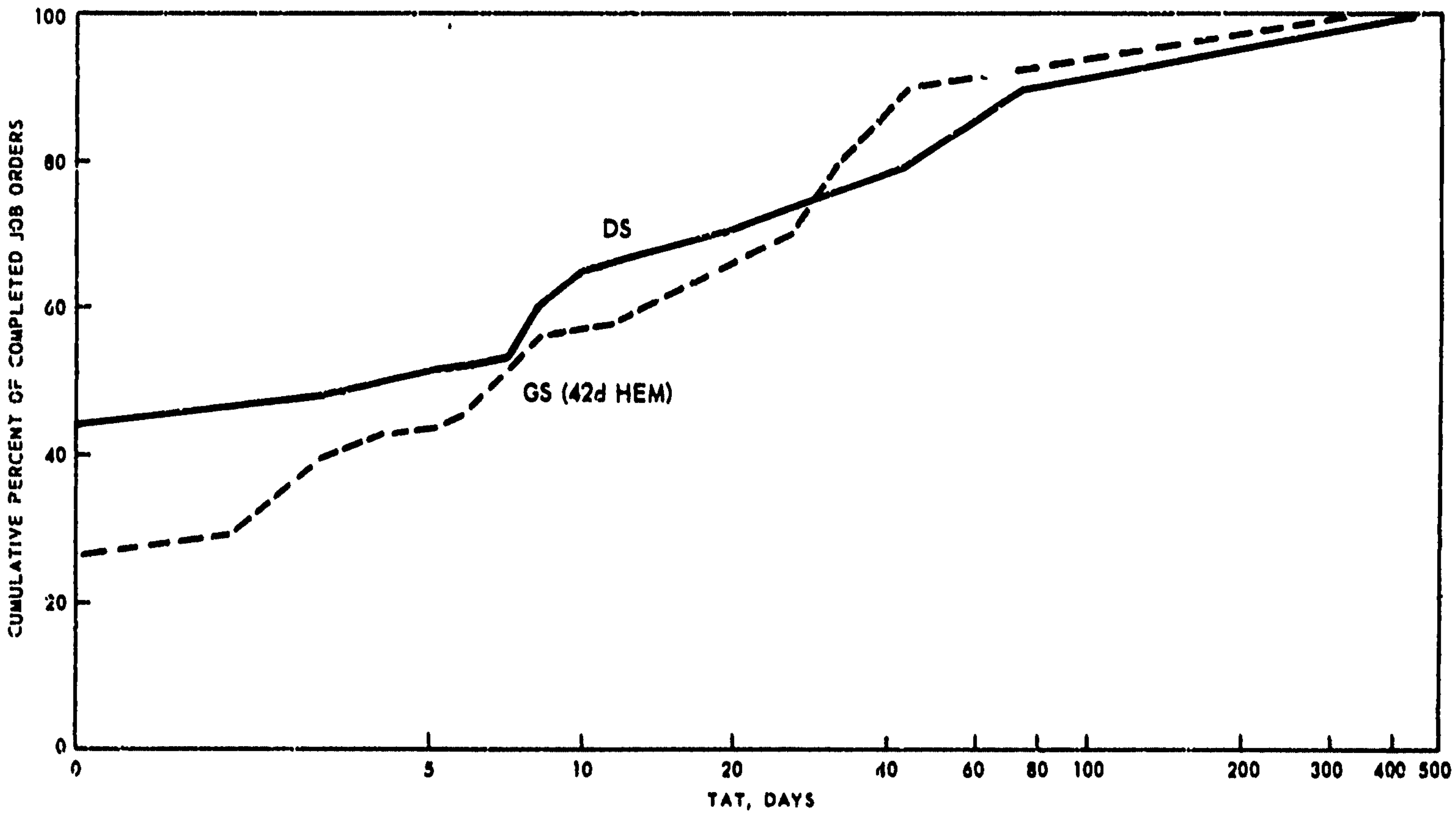

Fig. 27—Cumulative Distribution of Completed Job Orders for Armament Equipment

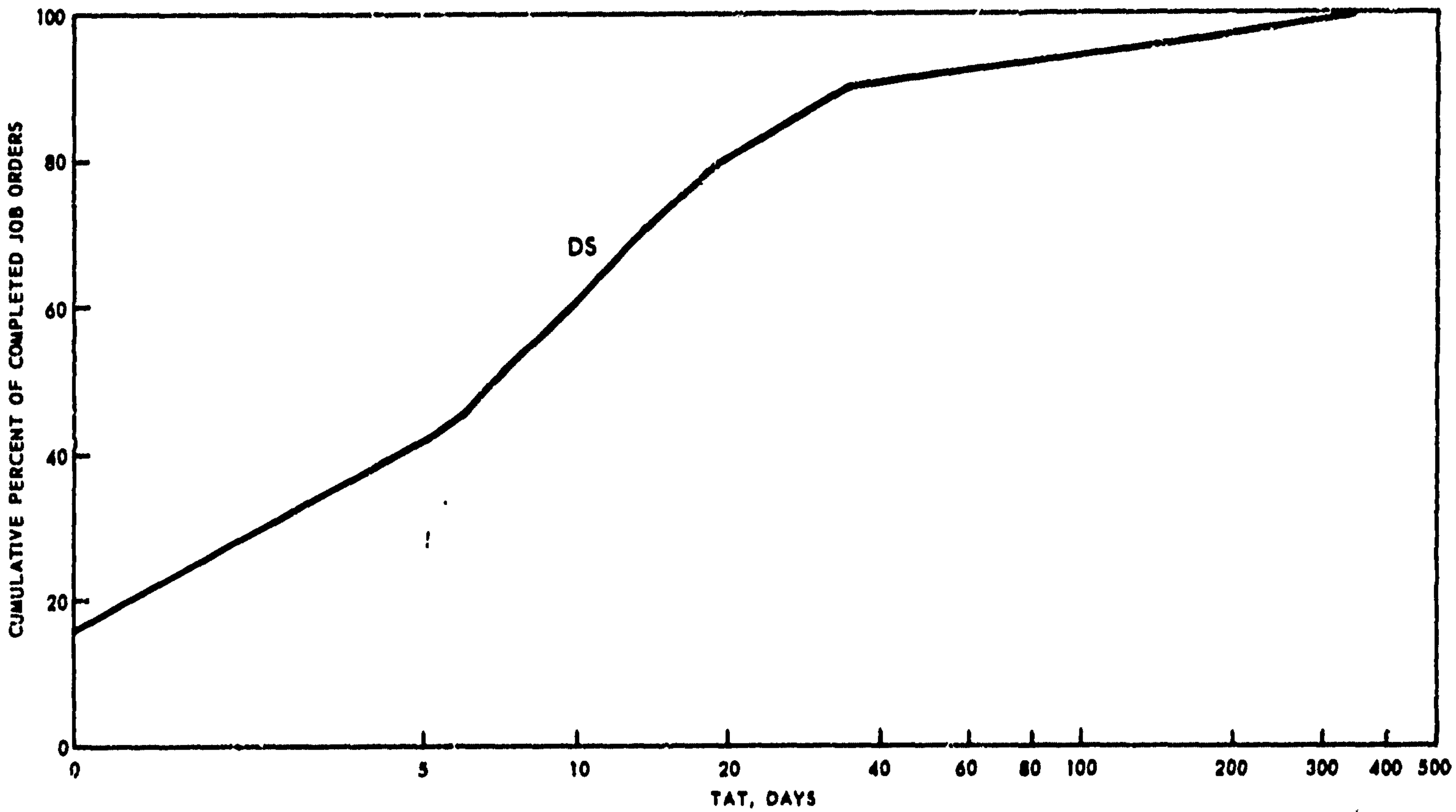

Fig. 28—Cumulative Distribution of Completed Job Orders for Aviation Equipment

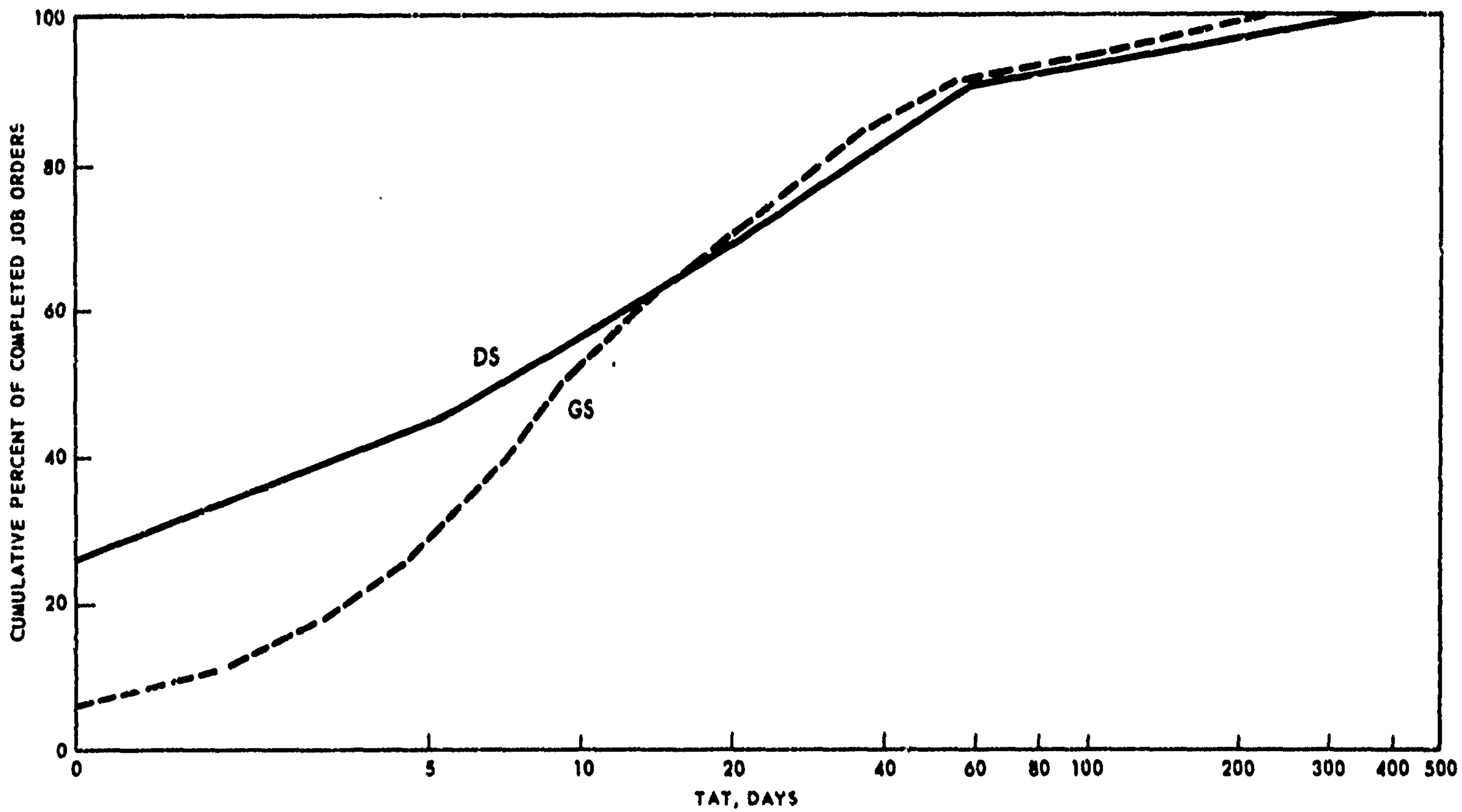

Fig. 29—Cumulative Distribution of Completed Job Orders for Automotive Equipment

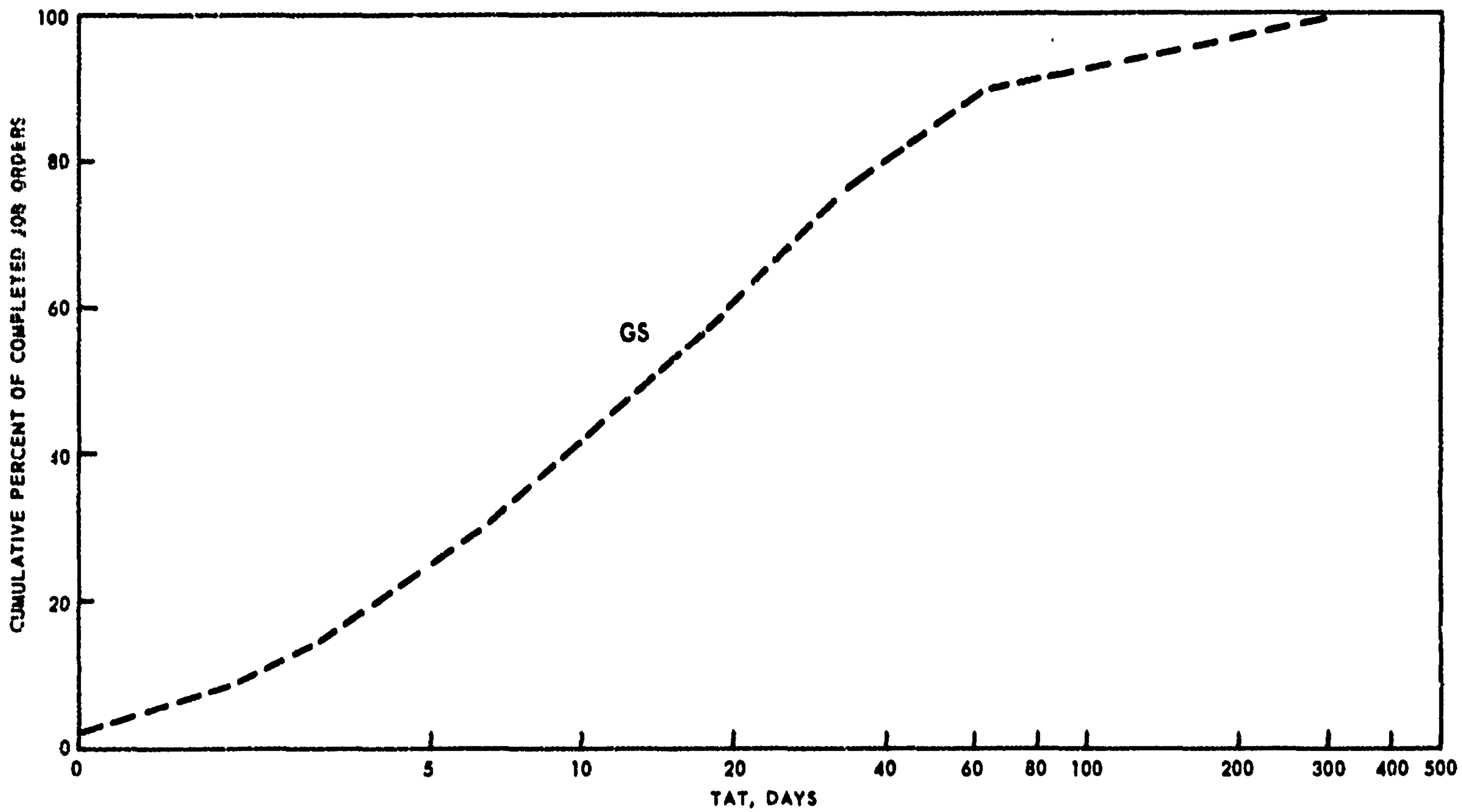

Fig. 30—Cumulative Distribution of Completed Job Orders for DX Components

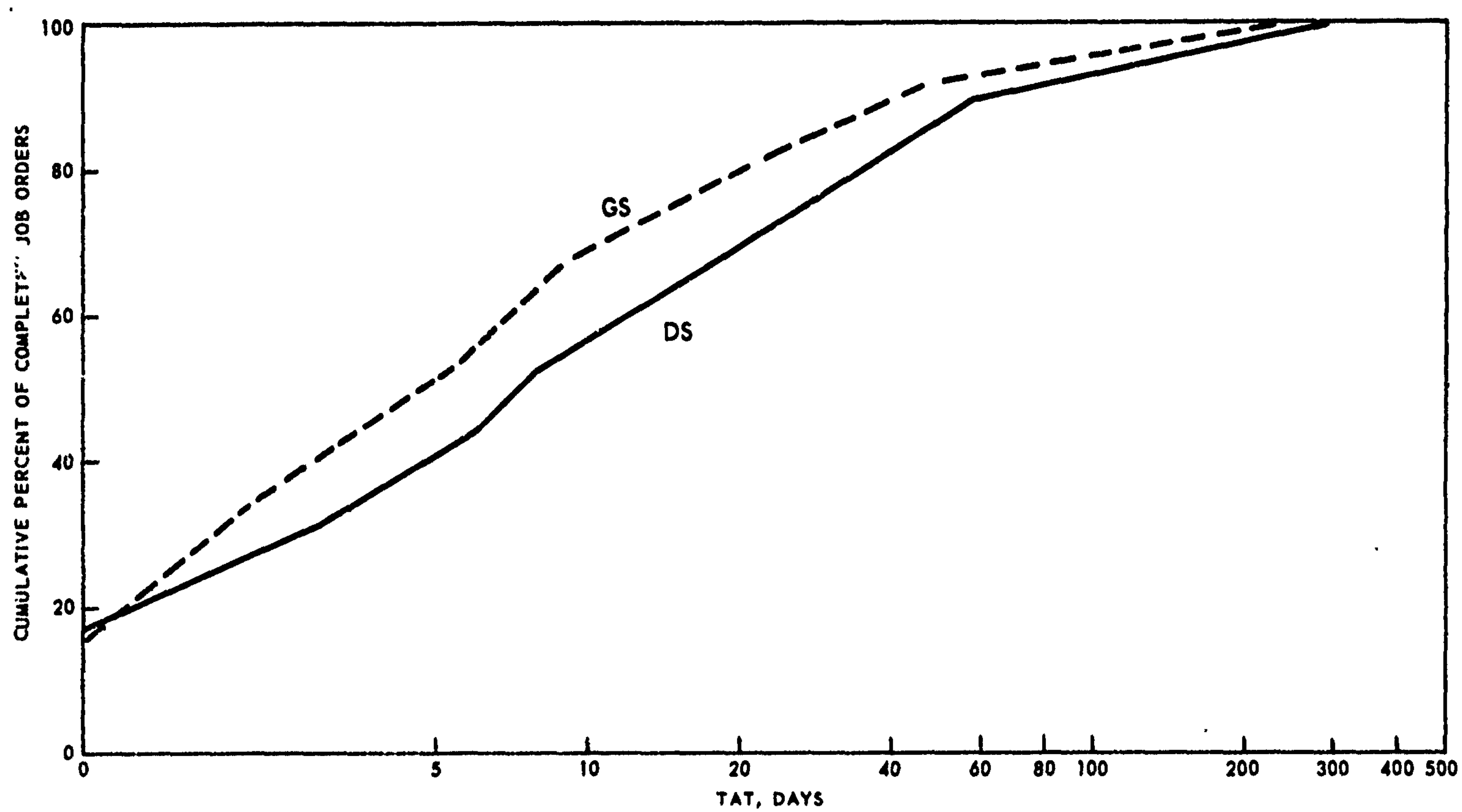

Fig. 31—Cumulative Distribution of Completed Job Orders for Electronics Equipment

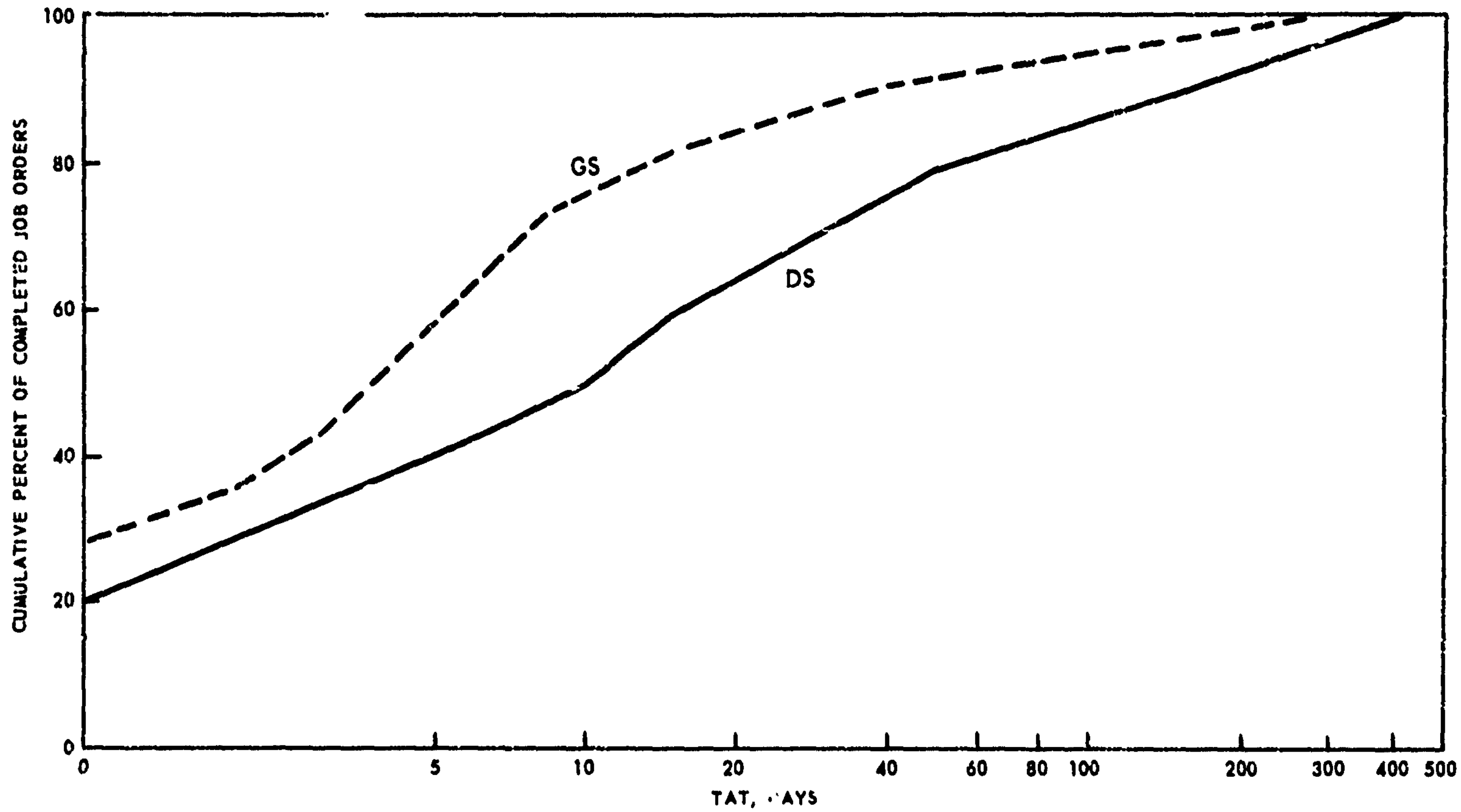

Fig. 32—Cumulative Distribution of Completed Job Orders for Engineer Equipment

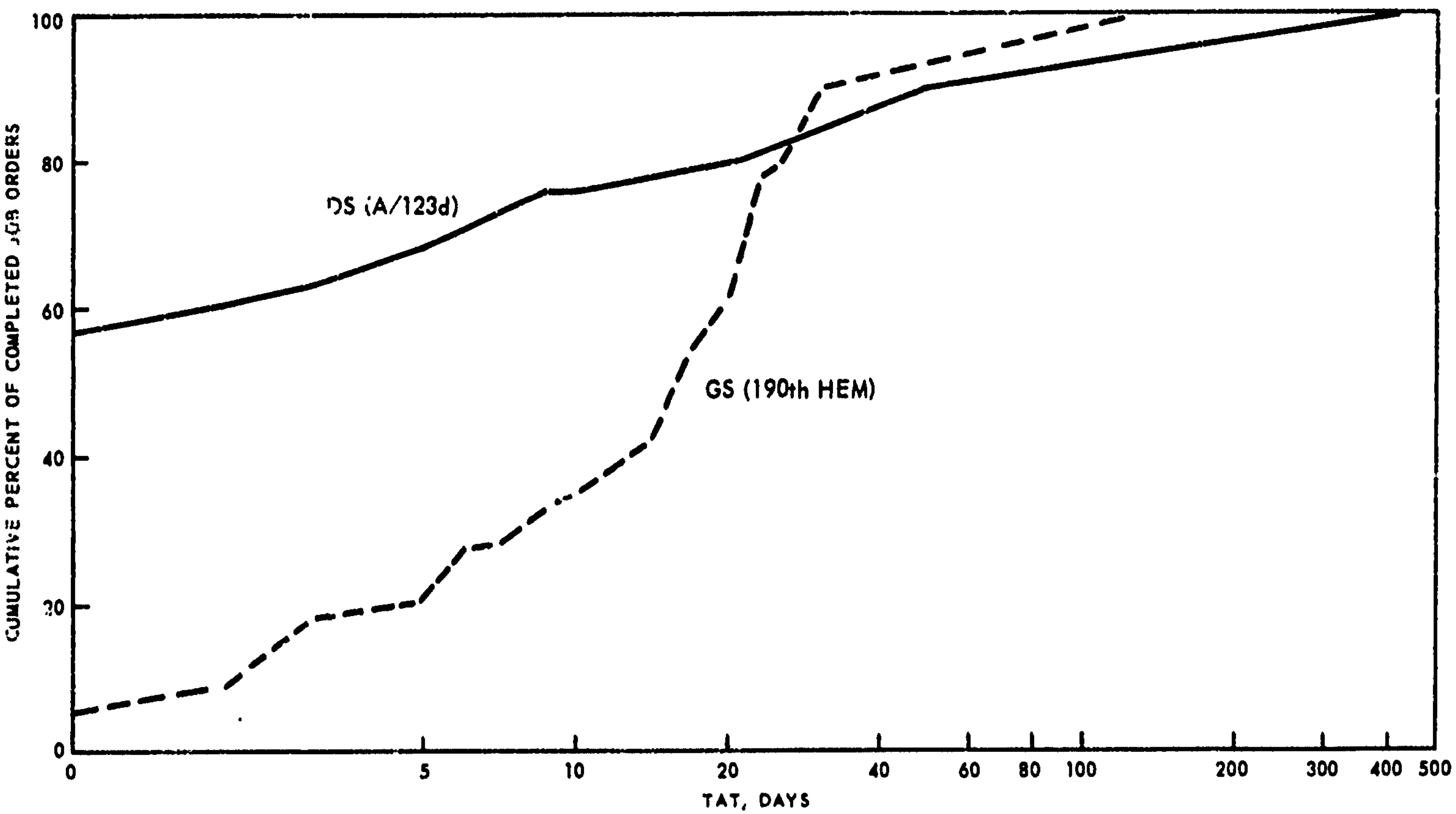

Fig. 33—Cumulative Distribution of Completed Job Orders for Small Arms

of repair parts. An examination of one DS battalion's backlog status and an analysis of manpower utilization (to be treated later in this chapter) indicate that the wait for repair parts is probably the chief cause of the extended TAT.

STATISTICAL TESTS

Logic dictates that a positive relation exists between selected pairs of maintenance measures, e.g., TAT and NORM, manpower utilization and TAT. Various combinations of maintenance measures were subjected to appropriate tests in order to determine if significant relations could be proven statistically. On the whole, these tests showed little if any positive correlation and in a few cases actually resulted in a high degree of confidence that an inverse relation (where a direct one was expected) existed between the compared measures. The following section describes the tests performed and the results obtained.

Regression Analysis

A regression analysis is one method used to determine statistical relations between two or more variables. The regression analysis applied to the maintenance data was performed using an on-line library program[22] available through a time sharing computer terminal.

An attempt was made to correlate TAT with the unit's manpower utilization index (MUI). A description of how the manpower utilization figures are arrived at is discussed later in this chapter. The hypothesis was made that as manpower utilization increased, TAT should be reduced. Manpower utilization ranged from 8 to 76 percent based on those TOEs that gave each unit the most favorable ratio of available direct labor to recorded man-hours.

Figure 34 illustrates the results of the regression analysis performed on these data. The curve shown is the estimated TAT days derived from the regression plotted against the actual days depicted by the data. The unit with the longest mean TAT (53 days) also possessed one of the lowest manpower utilization indexes, 8 percent. The unit with the highest MUI (76 percent) recorded one of the lower, but not the lowest, TAT of 16 days.

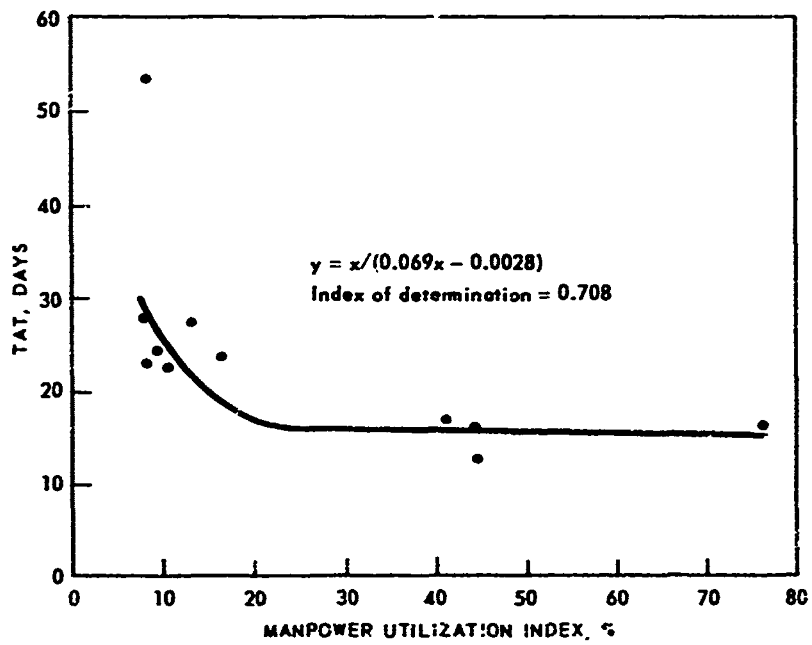

Fig. 34—Relation between Manpower Utilization and TAT

Assuming that the MUI is reasonably correct it is implied from this comparison that a nearly tenfold increase in the MUI buys only a threefold reduction in TAT. It might be concluded from such a result that the application of more manpower will give only marginal benefit in reduced TAT. This is particularly evident if the next highest TAT is used as the basis of comparison, 27 days TAT with 8 percent MUI vs 16 days TAT with 76 percent MUI. Once again it is apparent that lack of parts may be the chief influence in the excessively long mean TATs.

Other regression runs were made using the mean TAT for individual categories of equipment and unit MUI. Automotive resulted in a very low index of determination (42 percent). The runs for electronics were much better, 72 percent when the mean was used and 80 percent when a median TAT was used. The run for engineer equipment gave the best correlation, 90 percent. Overall, the results are at best spotty and without positive results sufficiently firm to conclude that MUI does in fact greatly influence the ability of a unit to shorten its TAT.

Two regression runs were performed comparing the number of job orders recorded by each unit vs the mean and median TAT. The resulting indexes of determination were 29 and 27 percent, respectively. If sheer volume of work orders has any significance with regard to TAT it is not apparent statistically.

Uniformity Test

In order to gain some insight into the composition of the population from which these maintenance data are drawn, a statistical test to determine the uniformity between the various TAT distributions was performed. The test used sets of paired data and assumes that the data from each sample come from the same universe, not necessarily normal.[49]

The results of this test are shown in Table 58. Only 7 of 23 matched pairs resulted in a positive answer. Six of these 7 were in fact qualified by virtue of a need for an increased sample size. The results indicate that overall, the universes from which each pair of data is drawn are dissimilar enough to prohibit any positive correlation to be inferred.

Table 58

TEST OF STATISTICAL UNIFORMITY BETWEEN DISTRIBUTIONS OF TAT

Equipment category	Units matched in test		Test indicates TAT distributions are uniform
Armament	A/123	C/123	No
	A/123	42d HEM	No
Aviation	B/123	B/124	Yes
Automotive	A/123	C/123	Yes
	A/123	8902d LS	No
	C/123	8902d LS	No
	A/124	A/123	No
	C/124	C/123	Yes[a]
	C/124	E/124	No
	190th HEM	A/124	No
	190th HEM	42d HEM	No
Electronics	A/124	C/124	No
	A/124	182d LEM	No
	E/124	C/124	No
	E/124	A/124	No
	C/123	C/124	No
	8905th LS	182d LEM	Yes
Engineer	A/123	182d LEM	No
	A/124	A/123	No
	8905th LS	42d HEM	Yes
	8905th LS	182d LEM	No
Small arms	A/123	8902d LS	Yes
	A/123	190th HEM	Yes

[a]Only unqualified positive result derived.

RELATION BETWEEN TAT AND THE NORM RATE

If one assumes that a support maintenance unit's effectiveness is most directly measured by its customer units' NORM rate, a direct correlation should exist between TAT and NORM.

Table 59 relates the mean TAT computed by quarterly intervals with the consolidated support NORM rate for comparable periods for two divisions.[11] The resulting relation is inverse to that which one might expect. Generally as TAT increases NORM tends to fall. Note the figures for division X, when TAT was 21 days the NORM reported was 1.9 percent. When TAT increased to 28 days, the NORM fell to 1.6 percent. NORM held at 1.6 percent during the 3d quarter while TAT decreased to 22 days, and increased to 3.0 percent when TAT dropped to 15 days. The same illogical pattern is evidenced by division Y.

Table 59

RELATION BETWEEN MEAN TAT AND SUPPORT NORM

Quarterly interval	Division X		Division Y	
	Mean TAT, days	Support NORM, %	Mean TAT, days	Support NORM, %
1	21	1.9	20	2.3
2	28	1.6	32	1.7
3	22	1.6	31	1.8
4	15	3.0	20	2.4

A comparison of TAT and NORM by equipment categories revealed a similar tendency. Although changes in the mean TAT appear to have little effect on automotive NORM (which held fairly constant regardless of the TAT) electronic and engineer equipment demonstrated the same inverse relation as the total. When the electronics TAT in one division was reduced from 25 to 17 days the NORM rate tripled from 2.0 to 6.3 percent.

Although no statistical explanation of these unexpected inverse relations is available, other factors suggest reasons for the apparent anomaly. These will be discussed later in this chapter.

MAINTENANCE BACKLOG

The 124th Maint Bn (DS) located at Ft Hood, Tex. maintained a Maintenance Status Report that furnished backlog information for the period 3 November 1970 - 2 November 1971. Figure 35 depicts the total number of jobs in maintenance at the end of each week showing their status as in shop, awaiting shop, or awaiting parts. Over the 1-year period the job orders on hand averaged 723 per week. The weekly total ranged from a low of 528 to a maximum of 1026 job orders. Over the year an average of only 12 percent of the backlog was in shop, while job orders awaiting shop averaged 26 percent. By far the bulk of the backlog, an average of 62 percent, was attributed to a lack of parts.

Some insight was gained from the list of critical items that accompanied the weekly status report. A total of 64 unique FSNs were listed as critical during the year, of which only 14 were so-called "hard core" or long-term critical items. Six of these hard core items remained critical for the entire period of observation. Because of the wait for parts, maintenance does not, nor could it reasonably be expected to provide instant repair and turnaround of equipment, hence some backlog is inevitable. The question arises, what would happen if all the necessary parts should be delivered simultaneously? Would the pattern simply change from one predominantly awaiting parts to one awaiting shop? The backlog data available from the 124th Maint Bn contained estimates of the man-hours required to perform each of the jobs currently in backlog. The average end-of-the-week backlog for tactical vehicles was approximately 14 man-days, based on an 8-hour workday. Man-days necessary to eliminate the backlog in combat vehicles averaged 17 days, and a weekly average of 14 days would be required to complete all the weapons jobs.

It would appear that a lack of manpower resources is not the influencing factor in the extended TAT. If in the case of tactical vehicles the total backlog at the end of the week is 14 man-days or 112 man-hours the application of additional manpower in the form of overtime or reduced nonproductive work time would greatly reduce or even entirely eliminate the backlog. As will be demonstrated in the section dealing with manpower utilization, manpower resources necessary

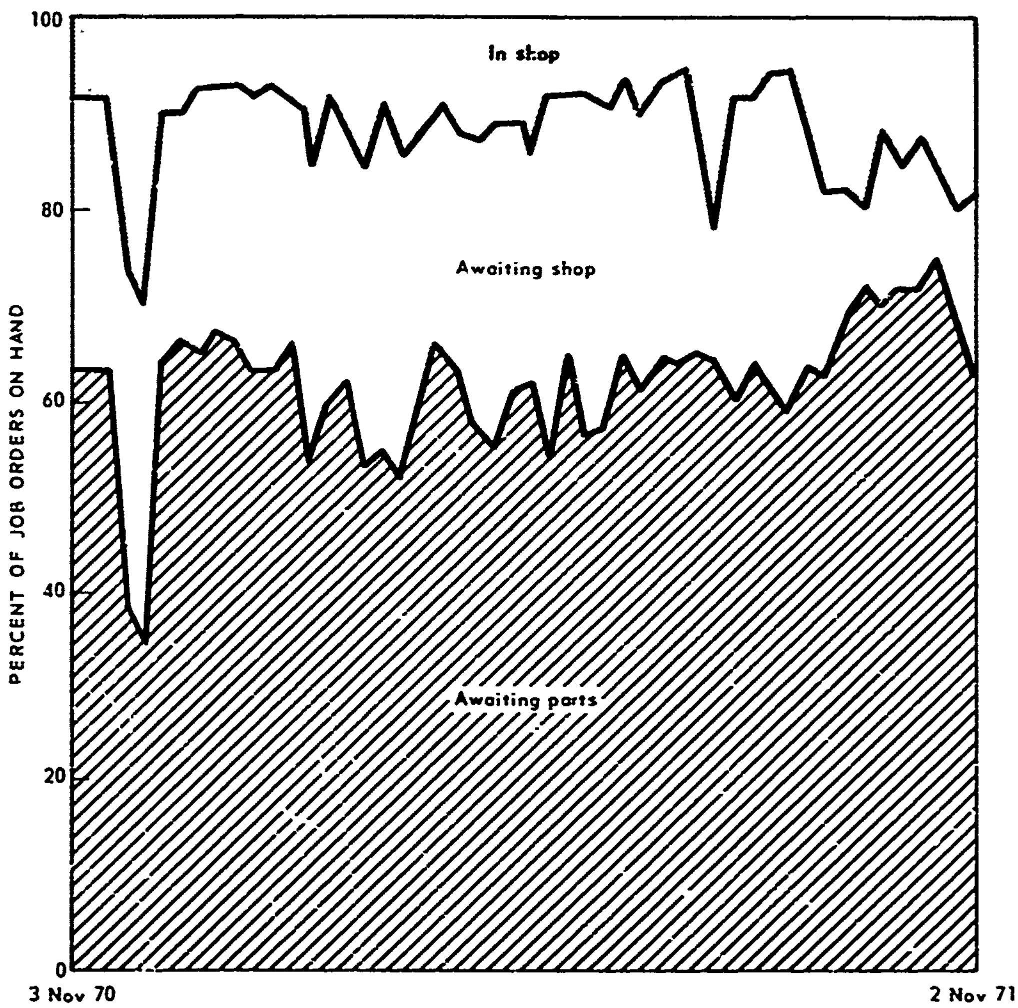

Fig. 35—Maintenance Backlog Status, 124th Maint Bn, 2d Armd Div

to eliminate any backlog were available given that repair parts necessary to complete the job were on hand.

MUI

The MUI is the ratio of man-hours actually expended on maintenance, i.e., "wrench turning" time, to maintenance man-hours available based on direct labor maintenance personnel assigned to the unit. The formula is:

$$\frac{\text{Number of direct labor man-hours reported}}{\text{Number of direct labor man-hours available}}(100) = \text{manpower utilization index, \%}$$

The source of data necessary to compute the MUI is the unit TOE, the morning report, and the job order register. This measure could be computed either on a unit or individual maintenance section basis.

An analysis of this type was first documented in the two RAC reports prepared for the Brown Board in the late 1960s.[1,46] An analysis of 26 DS and GS units in USAREUR indicated a range of manpower utilization from 1.8 to 55.7 percent of available time (the latter was a civilian labor service company).[46] Utilization figures for the individual companies of the DS maintenance battalions of the 3d and 4th Armd Divs ranged from a low of 4.9 to 16.8 percent in the 3d Armd Div and 4.4 to 11.0 percent in the 4th Armd Div.[1] At the time, both maintenance battalions were overstrength relative to their TOE authorizations.

Currently no official Army policy sets forth the number of annual available man-hours for TOE units operating in a peacetime environment. Annual man-hours as a planning factor are given in AR 570-2[50] and postulate a 12 hour man-day. Various deductions for nonproductive time are given, but these pertain to units operating under wartime conditions, and the resulting annual available man-hour range of 2500 to 3300 man-hours based on category designation of unit were not considered applicable to the analysis undertaken.

Two sets of estimates considering garrison-type operations were constructed and are shown on Tables C62 and C63 in App C. One estimate results in an annual available productive man-hour base of 1446 hours, which is referred to as the high estimate; the other using deductions

Table 60

MANPOWER UTILIZATION FOR MAIN SUPPORT COMPANY (DS)
FOR LOW AND HIGH ESTIMATES OF ANNUAL
AVAILABLE MAN-HOURS

Maintenance section	TOE series	Annual available man-hours		Percent utilization			
				A/123d		A/124th	
		Low estimate	High estimate	Low base	High base	Low base	High base
Armament	E	13,560	21,690	33	21	-[b]	-[b]
	G	15,368	24,582	29	18	-[b]	-[b]
	H	37,068	59,286	12	8	-[b]	-[b]
Electronics	E	46,104	73,746	-[b]	-[b]	28	18
	G	37,968	60,732	-[b]	-[b]	34	21
	H	-[a]	-[a]	-[b]	-[b]	-[b]	-[b]
Mechanical	E	230,520	368,730	9	5	3	2
	G	147,352	235,698	13	8	5	3
	H	121,136	193,764	16	10	6	4
Service	E	11,752	18,798	42	26	25	15
	G	10,848	17,352	46	29	27	17
	H	12,656	20,244	39	25	23	14
Total	E	301,936	482,964	10	6	8	5
	G	211,536	338,364	14	9	11	7
	H	170,856	273,294	17	11	13	8

[a]No electronics maintenance section included in this TOE.
[b]No data for this computation.

for nonproductive time given in RAC TP-331 [46] is the so-called low estimate of 904 annual available man-hours.

In addition to the high and low estimates of available man-hours the various maintenance TOEs (references 7, 37 and 51 to 59) that might be encountered were examined, and the number of direct labor personnel extracted. These are shown in Tables C64 and C67 in App C. The number of reported maintenance man-hours for each support unit is given in Tables C68 and C69.

Tables 60 to 64 present the estimated MUI for various TOEs as the result of utilizing both the high and low available man-hour figure. Seldom does the MUI approach 50 percent. For a main support DS company shown in Table 60 the highest MUI estimated is 46 percent. Forward DS companies covered in Table 61 show a high of 26 percent for the nonaviation companies and 76 percent for aviation. GS units indicate a high of 54 percent for a LEM Company (Table 62), 43 percent for a HEM Company (Table 63), and 60 percent for a civilian labor service unit (Table 64). It should be noted that the civilian labor operations are not burdened with the requirement to participate in nonmaintenance-connected activities to the same extent as the soldier-staffed TOE units, which may account at least in part for their apparent better utilization of manpower resources.

The results of the MUI analysis are of interest because they highlight an important facet of the maintenance question. If the backlog problem is one of simply applying more personnel resources it appears that these resources are available.

Based on the results obtained from the preceding analysis it is proposed that support maintenance unit commanders attempt to attain a 50 percent manpower utilization index. This could be modified by local commanders to as little as 25 percent to take into consideration variations in the workload.

Time Awaiting Parts

If a sizable portion of maintenance TAT is in actuality time awaiting parts, to which element of maintenance downtime should it be charged? NORS is defined as "the time elapsed during which maintenance actions cannot be started or continued due to the nonavailability of

Table 61

MANPOWER UTILIZATION FOR A LIGHT EQUIPMENT GENERAL SUPPORT MAINTENANCE COMPANY FOR LOW AND HIGH ESTIMATES OF ANNUAL AVAILABLE MAN-HOURS

182d LEM Co

TOE 29-134 G

Maintenance section	Annual available man-hours		Percent utilization	
	Low estimate	High estimate	Low base	High base
Chemical	25,312	40,488	14	9
Quartermaster	13,560	21,690	48	30
Service	18,984	30,366	29	18
Other[a]	93,112	148,938	54	34
Total	150,968	241,482	44	27

[a]Includes:

Electronic/electrical
Engineer
Radar/radio
Special equipment
Telephone/telegraph

RAC

Table 62

MANPOWER UTILIZATION FOR DIRECT SUPPORT, FORWARD SUPPORT, AIRCRAFT MAINTENANCE, AND LABOR SERVICE COMPANIES FOR LOW AND HIGH ESTIMATES OF ANNUAL AVAILABLE MAN-HOURS

TOE series	Annual available man-hours		Percent utilization											
			B/123		C/123		B/124		C/124		E/124		8902d LS	
	Low estimate	High estimate	Low base	High base	Low base	High base	Low base	High base	Low base	High base	Low base	High base	Low base	High base
Forward Support Companies														
E	44,296	70,854	-	-	8	5	-	-	26	16	8	5	-	-
G	71,416	114,234	-	-	5	3	-	-	16	10	5	3	-	-
H	97,632	[illegible]	-	-	4	2	-	-	12	7	4	2	-	-
Aircraft Maintenance Companies														
G	28,928	46,276	41	26	-	-	76	48	-	-	-	-	-	-
H	39,776	63,624	30	19	-	-	56	35	-	-	-	-	-	-
Labor Service Company														
G	—[a]	196,656	-	-	-	-	-	-	-	-	-	-	-	44

[a]Not applicable to a civilian-staffed operation.

Table 63

MANPOWER UTILIZATION FOR GENERAL SUPPORT HEAVY EQUIPMENT MAINTENANCE COMPANY FOR LOW AND HIGH ESTIMATES OF ANNUAL AVAILABLE MAN-HOURS

TOE 29-137G

Maintenance section	Annual available man-hours		Percent utilization			
			42d		190th	
	Low estimate	High estimate	Low base	High base	Low base	High base
Armament	6,328	10,122	40	25	—	—
Automotive	85,880	137,370	7	5	6	3
Components	16,272	26,028	33	20	16	10
Engineer	18,030	28,920	43	27	6	4
Instruments	8,136	13,812	—	—	26	16
Service	19,888	31,812	—	—	20	13
Small arms	5,424	8,676	—	—	8	5
Special equipment	5,424	8,676	—	—	—	—
Total	165,432	264,618	13	8	9	6

Table 64

MANPOWER UTILIZATION FOR LABOR SERVICE COMPANY FOR LOW AND HIGH ESTIMATES OF ANNUAL AVAILABLE MAN-HOURS

TOE 29-449G

Maintenance section	Annual available man-hours		Percent utilization			
			8902d (DS)		8905th (GS)	
	Low estimate	High estimate	Low base	High base	Low base	High base
Total[a]	—[b]	196,658	—[b]	44	—[b]	60

[a]TOE does not show maintenance configuration.

[b]Not applicable to a civilian-staffed operation.

repair parts. NORS stops when the required repair part becomes available. Repair parts are considered to be 'not available' until a request/requisition is filled and the parts are delivered to the work site. However, if maintenance action can be continued during the repair parts request/requisition cycle the nonavailable time will be charged to maintenance..."[40]

Based on this guidance it would appear that much is left to the unit's discretion. If when work is begun the necessary parts are not on hand, NORS may be charged to time in shop. If the required parts are identified prior to starting the job but known to be out of stock then it would appear that the NORS time may be charged to time awaiting shop. NORM and NORS times are distinguished in the Materiel Readiness Report, but it is impossible to determine exactly where the NORS time is charged from an analysis of the job order registers. A review of the frequency distributions in App C indicates that some units apparently include the time awaiting parts as part of the time awaiting shop, while others charge some of this time to in-shop.

For example, A Co, 124th Maint Bn, completed 90 percent of its automotive job orders in 54 days; 13.5 days awaiting shop and 39.5 days in shop.* Conversely A Co, 123d Maint Bn, reached 90 percent completion in 75 days; 72.5 days awaiting shop and only one-half day in shop. A forward support unit (E Co, 124th Maint Bn) completed 90 percent of its electronics jobs in 78 days; 60.5 days are awaiting shop and 17.5 days in shop. A similar range of times is evident in nearly all the equipment categories reviewed.

Man-Hours Analysis

The fourth time element reported on the job order register is man-hours expended per maintenance job. Tables 65 and 66 illustrate the mean man-hours per job for DS and GS units.

*The days are nonadditive because each set is derived from a separate frequency distribution.

Although TAT may average 44 days as in the case of A Co of the 123d Maint Bn armament section (shown earlier in Table 57) the average number of maintenance man-hours expended per job is only 3.3 (Table 65). In the automotive area, DS mean TAT ranges between 16 and 37 days, whereas the average number of man-hours per job order is 5 to 20 hours. In DS electronics, mean TAT is 15 to 30 days with an average of 2 man-hours per job recorded. Engineer equipment for the two DS units averaged 29 to 79 days of TAT with reported maintenance time averaging 2.6 to 6.8 hours. Table 66 listing GS reported man-hours also shows relatively low man-hours per job order.

Another method of viewing the man-hours was to compare them to the total TAT and develop ratios for both DS and GS units. Tables 67 and 68 present the results of this analysis. Total TAT days were converted to hours using a 5.6 hour workday. This number was arrived at using the standard 2080 yearly man-hours to compute a ratio based on the nonproductive time as estimated in Table C62, App C.* For DS maintenance the ratio of recorded man-hours to total turnaround time ranged from a low of 0.005 to a high of 0.43. The range for GSUs varied from a low of 0.008 to a high of 1.394. These numbers serve to illustrate that much of the extended time in shop is in reality not devoted to wrench turning. The analyses of man-hours and manpower utilization tend to reinforce the premise that much of the long TATs are in fact caused by parts shortages.

MAINTENANCE FLOAT

A maintenance float is designed to provide replacement materiel for items that will be out of service for an extended period of time for maintenance or overhaul. OR floats are required to replace equipment, the lack of which will degrade a unit's ability to carry out its mission. Repair cycle floats are used to replace equipment withdrawn

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*$\dfrac{\text{Workyear (hours), 2080}}{\text{Estimated annual productive hours, 1446}}$ (100) = 69.5% x 8 hours = 5.6-hour workday

Table 65

MEAN MAN-HOURS PER MAINTENANCE JOB ORDER FOR DSUs

Equipment	Unit	Job orders	Recorded man-hours	Mean man-hours
Armament	A/123	159	528	3.3
	C/123	421	727	1.7
Artillery	A/123	370	1,497	4.0
Automotive	A/123	1,713	12,263	7.2
	C/123	219	1,450	6.6
	A/124	1,068	5,296	5.0
	C/124	366	10,682	12.8
	E/124	225	1,971	8.8
	8902d LS	2,441	49,356	20.2
Aviation	B/123	1,144	11,889	10.4
	B/124	1,426	22,113	15.5
Calibration	A/123	127	259	2.0
Chemical	A/123	244	532	2.2
Electronic	C/123	438	945	2.2
	A/124	5,518	12,906	2.3
	C/124	268	632	2.4
	E/124	605	1,509	2.5
Engineer	A/123	351	916	2.6
	A/124	266	1,807	6.8
Fuel and electrical	A/123	2,582	3,260	1.3
Instruments	A/123	1,039	2,908	2.8
Service	A/123	1,949	4,981	2.6
	C/123	122	436	3.6
	A/124	1,001	2,890	2.9
	8902d LS	1,837	30,498	16.6
Small arms	A/123	1,596	2,435	1.5
	8902d LS	642	6,731	10.5

Table 66

MEAN MAN-HOURS PER MAINTENANCE JOB ORDER FOR GSUs

Equipment	Unit	Job orders	Recorded man-hours	Mean man-hours
Armament	42d HEM	340	2,527	7.4
Automotive	42d HEM	163	6,361	39.0
	190th HEM	580	4,727	8.2
	8905th LS	249	5,062	20.3
Calibration	190th HEM	161	192	1.2
	8905th LS	278	561	2.0
Chemical	182d LEM	564	3,571	6.3
DX Components	42d HEM	1,531	5,344	3.5
	8905th LS	622	5,662	9.1
Electronic	182d LEM	5,519	31,346	5.7
	8905th LS	3,910	41,007	10.5
Engineer	42d HEM	79	7,766	98.3
	190th HEM	203	1,147	5.7
	182d LEM	1,585	18,794	11.9
	8905th LS	1,437	25,903	18.0
Fuel and electrical	190th HEM	571	2,664	4.7
	8905th LS	3,256	29,710	9.1
Instruments	190th HEM	667	1,949	2.9
Quartermaster	182d LEM	545	6,511	11.9
Service	182d LEM	505	5,475	10.8
	190th HEM	1,016	4,044	4.0
	8905th LS	466	5,978	12.8
Small arms	190th HEM	328	453	1.4
Test equipment (electrical)	8905th LS	771	4,483	5.8

Table 67

RATIO OF RECORDED MAN-HOURS TO TIME IN SHOP, TOTAL TAT, DSUs

Equipment	Unit	Total TAT, days	TAT x 5.6 hour day	Recorded man-hours	Ratio
Armament	A/123	7,012	39,267	528	0.013
	C/123	10,356	57,994	727	0.013
Artillery	A/123	9,258	51,845	1,497	0.029
Automotive	A/123	47,965	268,604	12,263	0.046
	C/123	8,021	44,918	1,450	0.032
	A/124	21,567	120,775	5,296	0.044
	C/124	10,682	59,819	4,703	0.079
	E/124	5,128	28,717	1,971	0.069
	8902d LS	39,589	221,698	49,356	0.223
Aviation	B/123	19,003	106,417	11,889	0.112
	B/124	23,347	130,743	22,113	0.169
Calibration	A/123	5,456	30,554	259	0.008
Chemical	A/123	17,828	99,837	532	0.005
Electronic	C/123	10,903	61,057	945	0.015
	A/124	124,888	699,373	12,906	0.018
	C/124	3,977	22,271	632	0.028
	E/124	18,052	101,091	1,509	0.015
Engineer	A/123	9,558	53,525	916	0.017
	A/124	21,095	118,132	1,807	0.015
Fuel and electrical	A/123	40,626	227,506	3,260	0.014
Instruments	A/123	26,600	148,960	2,908	0.020
Service shop	A/123	58,825	329,420	4,981	0.015
	C/123	7,962	44,587	436	0.010
	A/124	10,310	57,736	2,890	0.050
	8902d LS	35,330	197,848	30,498	0.154
Small arms	A/123	27,605	154,588	2,435	0.016
	8902d LS	2,844	15,926	6,731	0.423

RAC

Table 68

RATIO OF RECORDED MAN-HOURS TO TIME IN SHOP,

TOTAL TAT, GSUs

Equipment	Unit	Total TAT days	TAT x 5.6 hour day	Recorded man-hours	Ratio
Armament	42d HEM	7,246	40,578	2,527	0.062
Automotive	42d HEM	2,079	11,642	6,361	0.546
	190th HEM	16,033	89,785	4,727	0.053
	8905th LS	3,013	16,873	5,062	0.300
Calibration	190th HEM	4,424	24,774	192	0.008
	8905th LS	6,650	37,240	561	0.015
Chemical	192d LEM	6,441	36,070	3,571	0.099
DX Component Repair	42d HEM	46,493	260,361	5,344	0.021
	8905th LS	10,234	57,310	5,662	0.099
Electronic	182d LEM	78,882	441,739	31,346	0.071
	8905th LS	61,205	342,748	41,007	0.120
Engineer	42d HEM	995	5,572	7,766	1.394
	182d LEM	12,973	72,649	18,794	0.259
	190th HEM	9,399	52,634	1,147	0.022
	8905th LS	38,987	218,327	25,903	0.119
Fuel and electrical	190th HEM	12,118	67,861	2,664	0.039
	8905th LS	37,787	211,607	29,710	0.140
Instruments	190th HEM	23,142	129,595	1,949	0.015
Quartermaster	182d LEM	8,660	48,496	6,511	0.134
Service shop	182d LEM	4,222	23,643	5,475	0.232
	190th HEM	14,655	82,068	4,044	0.049
	8905th LS	11,364	63,638	5,978	0.094
Small arms	190th HEM	6,163	34,513	453	0.013
Test equipment (electrical)	8905th LS	10,625	59,500	4,483	0.075

from the unit to undergo depot maintenance or overhaul. In the case of aircraft, crash damage requiring depot repair qualifies the item for a repair cycle replacement float. Details concerning the concept of maintenance float support, selection of items, eligibility criteria, determination of requirements, and computation of float factors are set forth in AR 750-1.[9]

Table 69 lists the standards set for the issue of OR maintenance floats. The standards on a priority basis, the unit's IPD determine which units have first call on the available float assets. No basis was found through which to validate these standards. They are presented here for reference.

Table 69

MAXIMUM REPAIR TIME LIMITS

In calandar days

Priority designation	Overseas	CONUS
IPD 1-3	12	8
IPD 4-8	15	12

TAT OBJECTIVES

In view of the anomalies evident in the maintenance data it is considered infeasible to attempt to set rigid TAT performance objectives based on these data. The wide discrepancies between the times recorded by different units for similar equipment categories and the lack of any appreciable statistical correlation between measures present a major obstacle to the determination of a statistical TAT. If in fact some large portion of TAT is not controllable by the DSU/GSU commander, e.g., lack of parts or maintenance personnel required to perform nonmaintenance duties, then the setting of any time-related performance objective must somehow consider those elements.

AR 750-1[9] publishes support maintenance mean times for selected items of equipment including in transit time, days awaiting shop, and days in shop. The table listing these times by model type was extracted and is shown as Table C70 of App C. All times are based on information collected as part of TAMMS and represent a much broader data

base than the one used in the RAC analysis. Although the TAMMS data encompass a much wider range of units and draw on a greater data base insofar as volume is concerned, a previous RAC study[60] of the system noted that problems of underreporting existed and that the general quality of the data could be improved. With that caveat in mind the reader should note that the TATs given are reflections of historical data and should not be interpreted as goals for maintenance performance. Basically the TATs reported are in line with the results obtained from the analysis of the RAC-collected maintenance data.

A model-by-model comparison of TAT from AR 750-1[9] and the RAC data was considered infeasible and was not attempted. Instead the comparison was made in terms of equipment category ranges, a broader concept more conducive to the setting of management goals. Tables 70 and 71 depict the support maintenance (DS and GS) times computed for the major categories of equipment for both USAREUR and CONUS. A mean TAT was computed using the times shown for individual models within the major category heading. When compared with the TAT (combined DS/GS) for similar equipment the results obtained from the RAC sample were comparable to the means computed using the TAMMS information. In the case of automotive equipment the computed mean based on the TAMMS data was 22.4 days (USAREUR) and 15.5 days (CONUS); the combined RAC sample DS/GS mean TAT (this includes both USAREUR and CONUS units) is 21.9 days. Electronics averaged 14.6 days for USAREUR and 11.8 days for CONUS vs 18.3 days for combined DS/GS. Engineer equipment proved to be very similar, with 23.5 days computed for USAREUR and 21.2 days for CONUS using the TAMMS data and 23.7 days for the RAC sample. Only two aviation units (both DS) contributed to the RAC sample for an average of 16.5 TAT, which is approximately three times longer than the 5.5 and 5.8 days of TAT computed from the TAMMS data. Only one unit reported artillery maintenance as such, too small a sample to use for comparative purposes.

Table 72 presents the weighted mean TATs for DSU/GSUs for each of the equipment categories encountered in the job order registers. The TAT for automotive equipment is almost identical for DS and GS whereas the TAT for electronic and engineer equipment is of longer duration at

Table 70

USAREUR SUPPORT MAINTENANCE TIME
COMPUTED FROM AR 750-1

Equipment category	Days in transit (1)	Days awaiting shop (2)	Days in shop (3)	Maintenance TAT, days (2 + 3)
Artillery				
Range[a]	2-3	3-15	5-6	9-20
Mean	2.7	9.3	5.3	14.6
Automotive				
Range	2-8	1-24	2-31	8-53
Mean	3.8	11.8	10.6	22.4
Aviation				
Range	1-2	1-1	4-5	5-6
Mean	1.5	1.0	4.5	5.5
Electronics				
Range	3-8	3-10	2-14	9-20
Mean	4.3	6.3	8.3	14.6
Engineer				
Range	1-8	2-20	1-23	7-43
Mean	3.9	10.4	13.1	23.5

[a]Range of standards for individual models within the equipment category.

Table 71

CONUS SUPPORT MAINTENANCE TIME
COMPUTED FROM AR 750-1

Equipment category	Days in transit (1)	Days awaiting shop (2)	Days in shop (3)	Maintenance TAT, days (2 + 3)
Artillery				
Range[a]	1-4	3-5	2-4	5-8
Mean	2.3	3.8	2.5	6.3
Automotive				
Range	1-8	2-20	1-15	4-30
Mean	4.3	8.2	7.3	15.5
Aviation				
Range	1-2	2-2	2-6	4-8
Mean	1.8	2.0	3.8	5.8
Electronics				
Range	1-5	1-10	1-18	2-20
Mean	3.2	4.3	7.5	11-8
Engineer				
Range	2-6	2-18	2-22	4-36
Mean	2.9	9.1	12.1	21.2

[a]Range of standards for individual models within the equipment category.

Table 72

WEIGHTED MEAN TAT FOR DS AND GS MAINTENANCE COMPUTED FROM RAC SAMPLE UNITS

Equipment category	Weighted mean TAT, days	
	DS	GS
Armament	29.9	21.3
Artillery	25.[illegible]	—[a]
Automotive	22.0	21.3
Aviation	16.5	—[a]
Calibration	43.0	25.2
Chemical	73.0	11.4
DX Components	—[a]	21.6
Electronics	23.1	14.9
Engineer	49.7	18.9
Fuel & Electrical	15.7	13.0
Instruments	25.7	34.7
Quartermaster	—[a]	15.9
Service shop	23.9	15.2
Small arms	13.6	18.8
Test equipment (electrical)	—[a]	13.8

[a]No data available.

DS than at GS. This is somewhat surprising in view of the fact that the repairs performed at GS are usually more sophisticated, so that theoretically a somewhat longer TAT at GS would be expected.

A problem facing anyone examining maintenance TAT is how to place the results into some perspective that allows one to view maintenance effectiveness measured against some qualitative objective accepted as reasonable.

One method of approaching this was to superimpose the maximum repair time limit standards set for the issue of maintenance float equipment against the reported range of mean TATs reported under TAMMS and the TATs computed for the units in the RAC sample. The TATs shown in Figs. 36 and 37 represent the variations in the ranges reported for individual model types within the major equipment categories as reported by TAMMS and the range of unit TATs for each major category.

Figure 36 illustrates these TATs and the announced maximum repair time governing the issuance of maintenance floats in CONUS. It is assumed for analytical purposes that all reporting units fall into the IPD 1-3 designation and that equipment comparable to that reported in AR 750-1 is repaired by the RAC sample units.

Artillery and aviation are not shown because of the small sample size and the fact that aviation materiel operates under a somewhat different repair time criterion, set by the local commander. The range for automotive equipment reported by units in CONUS was 20 to 29 days whereas the range for individual models reported under TAMMS was 4 to 30 days of mean TAT. For electronics, TAMMS reported 2 to 20 days of mean TAT vs 15 to 30 days for the RAC sample units. Engineer equipment showed an even greater spread with TAMMS reporting range of 4 to 36 days of mean TAT for individual models of materiel and the sample units 46 to 79 days of mean TAT.

Figure 37 depicts the USAREUR units in the RAC sample: automotive, 12 to 37 days; electronic, 14 to 25 days; and engineer, 8 to 29 days of mean TAT. The models reported under TAMMS indicate a mean TAT of 8 to 53 days for automotive equipment 9 to 20 days for electronics and 7 to 43 days for engineer materiel. It is evident from these two charts

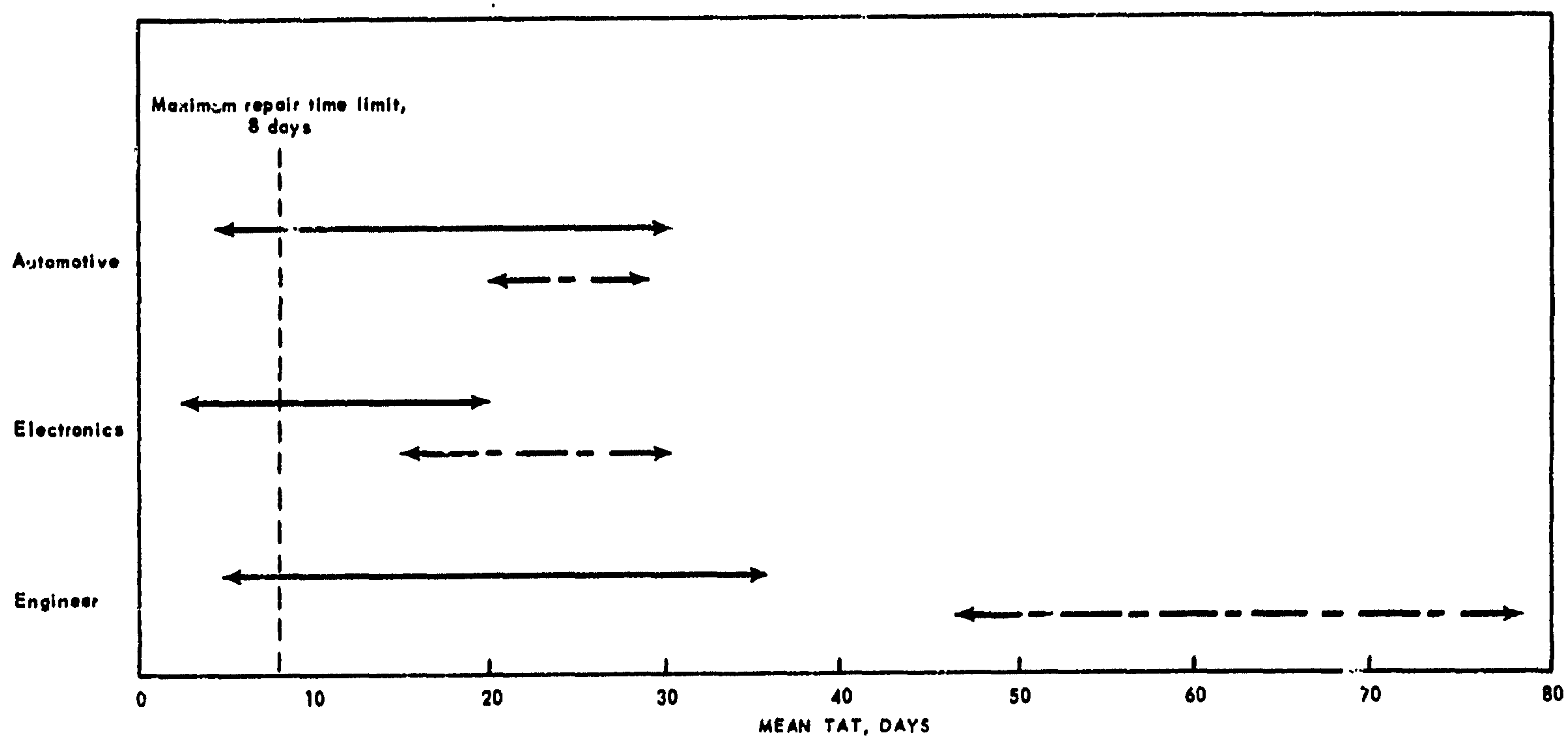

Fig. 36—Range of Mean TATs Compared with the Maximum Repair Time Limit Set for Issuance of Maintenance Floats, CONUS IPD 1-3

TAMMS, TAT by model — RAC sample, TAT by unit

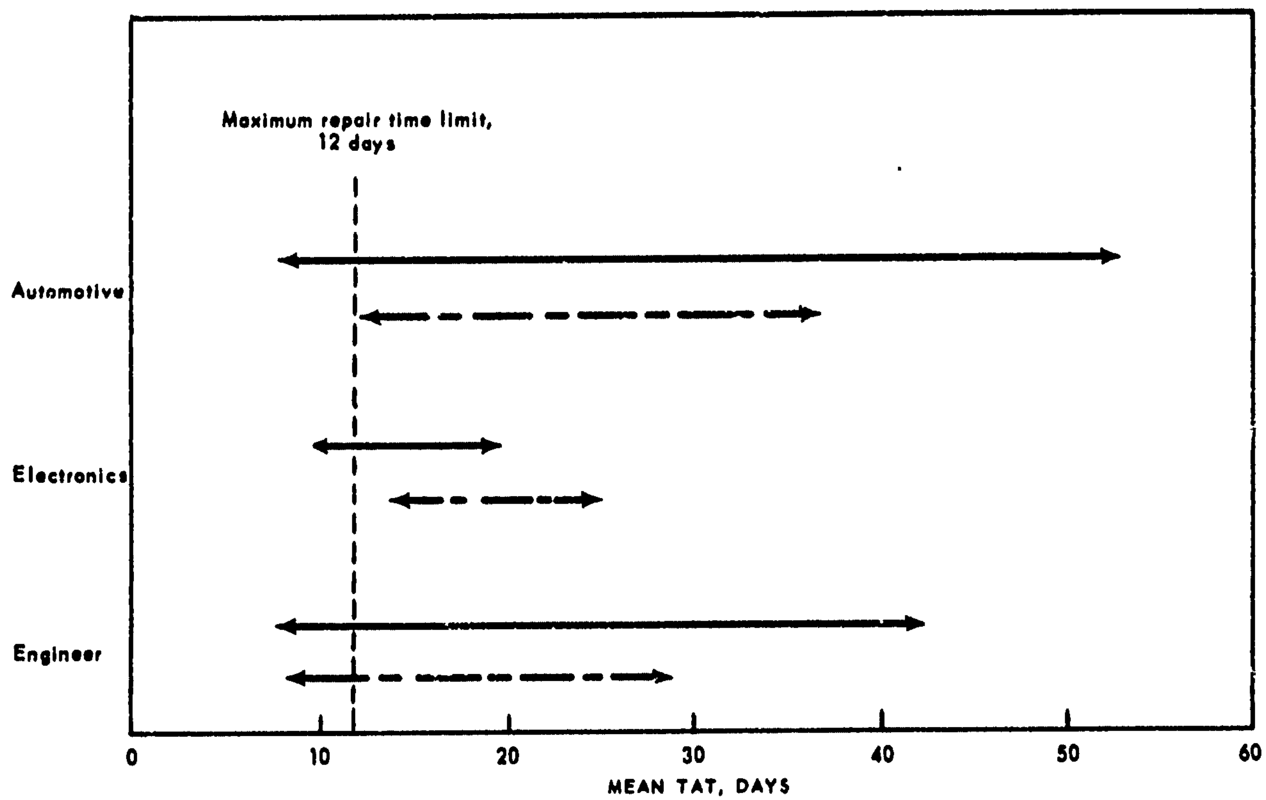

Fig. 37—Range of Mean TATs Compared with the Maximum Repair Time Limit Set for Issuance of Maintenance Floats, Overseas IPD 1-3

——— TAMMS, TAT by model — — — RAC sample, TAT by unit

that, overall, the maximum time limit is far exceeded by the reported TATs.

The TAMMS data were also tabulated by counting those model types reporting a TAT equal to or less than the maximum time limit and those with a TAT exceeding the time limit. Table 73 lists the number of model types within each major category meeting or exceeding these criteria. Although aviation may be operating under a different repair time requirement it is included for illustrative purposes.

Table 73

NUMBER OF EQUIPMENT MODELS MEETING OR EXCEEDING THE MAINTENANCE FLOAT MAXIMUM REPAIR TIME LIMITS

Equipment category[a]	USAREUR		CONUS	
	≤12 days	>12 days	≤12 days	>12 days
Artillery	4	--	6	--
Aviation	1	2	4	--
Automotive	6	19	3	26
Electronics	2	2	2	4
Engineer	4	11	2	13

[a]Based on the model types reported in AR 750-1.[9]

The Air Force repair cycle time for all types of nonexpendables is set at 10 days. The standard for critical items is 3 days.[30] It is obvious from all the analyses shown that TAT is extremely long for a large percentage of the Army equipment. If a customer is not fortunate enough to have his equipment repaired within the first 10 days, chances are he has a long wait ahead unless his item qualifies for replacement by a float item, assuming one is available for issue.

The distributions shown previously in Figs. 27 to 33 reveal that approximately 50 percent of the items are currently repaired within a 10 day period. It is suggested that a TAT of 10 days or less be established as an overall goal. It is further suggested that local commanders examine their respective performance data and set more stringent objectives where so indicated.

OTHER MAINTENANCE MEASURES

The following measures and indicators of maintenance performance are offered as a guide for use by DSU/GSU commanders to gauge the operational efficiency of their maintenance function. It is obvious from the preceding analyses of TAT that various external factors influence the day to day operations of a DSU/GSU. A partial list would include:

1. Lack of repair parts or replacement components.

2. Lack of qualified maintenance personnel.

3. Seasonal variations in the workload caused by field training exercises, trips to training sites, etc.

4. Poor organizational maintenance.

5. Lack of essential special tools and/or test equipment.

6. Assignment of maintenance personnel to nonmaintenance-related duties.

7. Introduction of new items of equipment that develop engineering problems under field use conditions.

8. Sudden influx of higher priority work.

Given that some important elements contributing to the workload and performance are out of the hands of the DSU/GSU commander, he still must be aware of certain management information that may help him to distribute his resources of men, parts, and facilities to the best possible advantage. The series of measures and indicators listed in this section are considered to be of importance to the DSU/GSU commander for this reason.

Their very nature precludes the setting of any objective. It must be left to the discretion of the maintenance manager to decide when a management indicator exceeds the norm and requires the application of additional resources, if available.

Ratio of Man-hours to Time in Shop

This ratio is arrived at by dividing the total number of maintenance man-hours recorded for a specific period by the total number of elapsed days in shop (total TAT) multiplied by the appropriate hours per standard work day. The formula is:

$$\frac{\text{Total man-hours recorded}}{\text{Total days in shop x man-hours per standard work day}} (100) = \text{ratio}$$

If after maintenance has begun on a specific job, it must be temporarily curtailed, the time of curtailment should be subtracted from the total time in shop, if possible. Reasons for curtailment would include (1) nonavailability of parts, (2) awaiting access to test equipment, and (3) shortage of manpower and/or facilities due to arrival of jobs of higher priority.

The source of data is the job order register. Samples of this measure are offered in the section of this chapter dealing with the analysis of maintenance man-hours. No objective as such is set because of the variations in types of job encountered. The measure is offered as a management guide to the local support unit commander.

Workload and Backlog Indicators

The following measures relate to workload and backlog at a maintenance facility and could be measured at the end of specified reporting periods:

1. Number of job order requests received.
2. Number of job orders evacuated to another maintenance activity.
3. Ratio of job orders evacuated to job orders received.
4. Number of job orders undertaken and completed and man-hours expended on completed work.
5. Number of job orders awaiting shop and estimated man-hours required to complete these jobs.
6. Number of uncompleted job orders in shop and estimated man-hours required for completion.
7. Number of job orders awaiting parts and estimated man-hours to complete these jobs once parts are available.
8. Total backlog expressed as number of uncompleted job orders and estimated man-hours represented by this backlog.

Input for the above measures could be obtained from the job order register, the backlog status report (if currently maintained), the shop management status board, or other locally maintained reports, registers, or files. The indicators shown above are intended for internal management by the local commander without the imposition of objectives. These must be decided at the unit level and may be used to regulate the work flow and application of manpower, facilities, parts, etc.

SUMMARY

This chapter examines the relation between maintenance and the other primary function of a DSU — supply. Maintenance effectiveness as reflected in the customer's NORM rate is also addressed.

It is proposed that the ultimate measure of DSU/GSU efficiency in satisfying customers' maintenance requirements is the rapidity with which the DSU/GSU effects repairs and returns the item to the customer. This measure is termed "turnaround time." There exist certain external influences over which the DSU/GSU commander has little if any control, e.g., repair parts OST, the requirement to furnish personnel for nonmaintenance-related activities, etc. Although attempts to correlate different maintenance measures statistically, e.g., mean TAT with NORM, have failed to produce a statistical relation, logic dictates that such a relation does indeed exist.

The assumption that the lack of repair parts is causative of long TATs is supported by the analysis of the backlog status report from the 124th Maint Bn, Ft Hood, which revealed that during the 1 year period November 1970 - November 1971 an average of approximately 62 percent of the job orders constituting the backlog were due to a lack of repair parts. Analyses of the recorded maintenance man-hours illustrate the low ratio of man-hours expended compared with time in shop. That application of more manpower would reduce backlog is contraindicated by low manpower utilization rates. Finally, distributions developed from the job order register indicate that some units record extremely long periods of time devoted to awaiting shop with relatively rapid in-shop repair times recorded. Conversely other units record the work in shop almost immediately and then register lengthy times in shop and yet record low maintenance man-hours.

TATs based on the data from the RAC sample units and TATs extracted from TAMMS as shown in AR 750-1,[9] when compared with the maximum repair time limits set for the issuance of maintenance floats, indicate that in the case of automotive, electronic, and engineer equipment the limit is generally exceeded.

Distributions of TAT disclose that 50 to 60 percent of the job orders are completed within 10 days whereas the remaining 40 to 50

percent stretch to 200 to 400 days. The causative factors involved in these extremely long TATs are probably beyond the influence of the local support unit commander. It is suggested that the setting of a TAT goal of 10 days or less would give the support units some bench mark against which to measure their effectiveness.

A summary of the various maintenance performance measures and indicators discussed in this chapter is offered in Table 74.

Table 74

SUMMARY OF MAINTENANCE PERFORMANCE MEASURES, INDICATORS, AND OBJECTIVES

Performance measure or indicator	Importance of measure or indicator	Suggested objective	Basis for selecting this objective
Support NORM	Primary measure of the DSU/GSU maintenance effectiveness	<2%	Empirical data
Turnaround time	Measures efficiency of customer support by DSU/GSU	< 10 days	Analysis of empirical data
Manpower utilization index	Important personnel management tool	25-50%	Analysis of empirical data
Ratio of maintenance man-hours to time in shop	Indicates the portion of total downtime actually spent on maintenance	—[a]	Analysis of job order documents
Workload			
Number of job orders: •Received •Evacuated •Undertaken and completed •Man-hours expended on completed work	Measures volume of maintenance activity	—[a]	Analysis of job order documents
Backlog			
Number of job orders awaiting shop Estimated man-hours required to complete Number uncompleted job orders in shop Estimated man-hours to complete once parts are available Total backlog: •Number of uncompleted job orders •Estimated man-hours required to complete	Permits commander to establish reasons for and extent of backlog in his shop	—[a]	Locally maintained files as required

[a]These measures and indicators are intended as management aides for the support unit commander. Quantitative goals or objectives should be established locally.

Appendix A

US ARMY STUDY ADVISORY GROUP

for

LOGISTICS PERFORMANCE MEASURES STUDY

Name	Organization	Status
Mr. John E. Hedeen	DALO-SM	CHAIRMAN
COL William P. Madigan	DALO-SUP	ALT CHAIRMAN
BG Theme T. Everton	DALO-PDS	Member
LTC Dale F. Stuart	DALO-SMD	Member
Mr. Edward J. Sarrazin	DALO-ZSM	EX SECRETARY
Mr. Paul J. Halle	DALO-MSTO	Member
Mr. Marvin T. Dennis	DALO-LDSRA	Member
Mr. John D. Taylor	DALO-PDS	Alternate
COL Clifford C. Reynolds	DALO-PDS	Observer
LTC Roy J. Dittamo	DALO-LSO	Observer
Mr. James J. Loughran	DALO-LSO	Observer
Mr. Wayne A. Smith	DALO-ZS	Member
Dr. Daniel Willard	ODUSA (OR)	Member
Dr. Wilbur B. Payne	ODUSA (OR)	
LTC J. O. Woodard	CSAVCS-P	Observer
MAJ W. G. T. Tuttle, Jr.	CSAVCS-S	Observer
MAJ W. N. McGrath	CSAVCS-P	Observer
LTC O. J. Sanders	AMCDT-M	Member
Mr. J. A. Burdette	AMCDT-M	Alternate
MAJ George W. Paroline	HQCDC (CDCCS-DS-Q) (Ft Belvoir)	Observer
Mr. George Hutchinson	HQCDC (CDCCS-DS-Q) (Ft Belvoir)	Observer
LTC John W. McKinney	HQCDC (CDCCD-C) (Ft Belvoir)	Observer
Mr. Stanley J. Biscoe	HQCDC (CDCPALSG) (Ft Lee)	Member
Mr. John C. McNichol, Jr.	CONARC (ATLOG-LM/M) (Ft Monroe)	Member
Mr. Boris Levine	OCE (DAEN-MEP-O)	Member
LTC Anthony P. Simkus	DARD-ARS-M	Member

Appendix B

DATA RELATED TO MEASURES OF SUPPLY PERFORMANCE

Tables

Table B1

FREQUENCY DISTRIBUTION FOR FSN DEMANDS
USED AS INPUT TO SCM RUNS

	Number of FSNs				Number of FSNs		
Demands	Division A	Division C	Division B	Demands	Division A	Division C	Division B
1	9674	7511	13910	36	12	24	44
2	2900	2530	5701	37	23	15	46
3	1578	1258	2951	38	11	19	37
4	958	829	1951	39	22	26	38
5	715	537	1363	40	22	12	38
6	520	400	1066	41	16	17	37
7	398	335	794	42	13	10	23
8	327	257	703	43	12	10	25
9	272	190	568	44	11	10	31
10	240	180	499	45	12	12	33
11	199	158	363	46	10	14	34
12	164	121	324	47	13	6	20
13	144	129	275	48	11	12	26
14	142	104	211	49	13	10	33
15	96	88	230	50	6	9	27
16	92	85	189	51	6	13	19
17	92	97	183	52	7	7	21
18	75	68	142	53	8	11	21
19	77	59	166	54	12	9	15
20	65	67	149	55	6	8	11
21	66	19	132	56	13	6	21
22	45	57	122	57	9	6	11
23	63	45	118	58	8	9	17
24	47	47	93	59	11	9	15
25	43	39	97	60	6	4	23
26	40	24	76	61	2	13	24
27	32	22	83	62	9	5	20
28	42	25	86	63	3	9	16
29	38	25	75	64	9	4	22
30	36	29	70	65	5	2	12
31	20	19	54	66	6	5	9
32	38	28	45	67	3	7	5
33	27	16	52	68	6	2	6
34	14	22	48	69	1	6	12
35	20	14	49	70	11	7	13

Table B1 (continued)

Demands	Number of FSNs: Division A	Division C	Division B
71	1	4	8
72	2	5	5
73	6	3	8
74	1	5	5
75	3	1	13
76	3	2	2
77	4	4	9
78	5	4	8
79	4	6	111
80	1	4	8
81	3	5	8
82	2	4	7
83		2	9
84	5	5	2
85	4	4	6
86	4	4	6
87	1	2	6
88	5	6	7
89	7		10
90	1	2	4
91	3	2	6
92	6	1	7
93	5	2	11
94	2	4	9
95	5	3	4
96	5		7
97	2	1	5
98	3	2	3
99	1	3	8
100	3	3	5
101	3	2	1
102	4	2	9
103	2	3	4
104	2	1	5
105	3	6	9
106	5	3	10
107	3	4	9
108	4		5

Demands	Number of FSNs: Division A	Division C	Division B
109	2	2	4
110	2	4	3
111		4	3
112		2	2
113		2	1
114	1	1	6
115	2		2
116	3	4	3
117	3		2
118	1	2	4
119	1	1	5
120		1	2
121	1	3	6
122	1	2	1
123	2	1	4
124		1	4
125	1		6
126	1	3	1
127		2	2
128	1		4
129	1		3
130	3	1	1
131	2	2	4
132	1	1	1
133		3	2
134	1	1	4
135	1	4	2
136		2	4
137			1
138		1	3
139	1		4
140	1	1	4
141	3	1	2
142	1	1	1
143			2
144		1	3
145			6
146			1

Table B1 (concluded)

	Number of FSNs				Number of FSNs		
Demands	Division A	Division C	Division B	Demands	Division A	Division C	Division B
147	1		4	181		1	2
148			2	182	1		2
149		2	2	183	1		1
150	1		1	184		1	1
151	1		4	185		1	1
152		2	4	186		1	
153	1	1	3	187	3	1	2
154		1	2	188	1	2	
155				189			1
156		1	2	190			2
157		1	2	191			1
158		1	3	192			
159	2		2	193			
160		1	3	194	1		5
161			1	195	1		2
162	1		2	196		1	4
163	1		2	197	1		
164		1	1	198	16	27	
165			2	199			1
166	1	1	4	200			1
167			4				
168			1				
169							
170		1	1				
171	2						
172		1	3				
173	1						
174	1		1				
175		1					
176	1	2	2				
177		2	2				
178	2						
179							
180		1	1				

Total demands over 200/FSN = 61,324 by 153 FSNs

Average demands over 200 = 401

Table B2

DEMAND DATA FOR SPSM ANALYSIS - DIVISION C

Class structure				Totals for all FSNs in this class						Averages for FSNs in this class					Prob. of initial stockage,[a] this class
Code	Demands Number	Demands Quantity	Unit price range	No. of FSNs	Unit price	Unit weight (lbs)	Unit cube, ft³	Annual demands	Annual quantity demanded	Unit price	Unit weight (lbs)	Unit cube ft³	Annual demands	Quantity per demand	
1	1	0-10	0-1.00	2289.000	797.930	977.110	163.555	2289.000	6232.000	.349	.474	.079	1.000	2.723	.001
2	2	0-10	0-1.00	890.000	323.590	282.340	18.489	1780.000	5481.000	.364	.337	.022	2.000	3.079	.024
3	3	0-10	0-1.00	424.000	147.290	78.800	5.844	1272.000	4211.000	.347	.198	.015	3.000	3.311	.165
4	4	0-10	0-1.00	260.000	98.660	96.080	6.776	1040.000	3112.000	.379	.392	.028	4.000	2.992	.474
5	5	0-10	0-1.00	183.000	71.910	27.690	1.818	915.000	2935.000	.393	.167	.011	5.000	3.209	.755
6	6	0-10	0-1.00	122.000	40.140	30.090	1.183	732.000	2570.000	.329	.257	.010	6.000	3.511	.899
7	7	0-10	0-1.00	125.000	42.290	27.430	1.655	875.000	3385.000	.338	.231	.014	7.000	3.869	.959
8	8	0-10	0-1.00	84.000	28.760	15.710	.907	672.000	2310.000	.342	.189	.011	8.000	3.438	.983
9	9	0-10	0-1.00	64.000	22.060	5.730	.437	576.000	2576.000	.345	.094	.007	9.000	4.472	.993
10	10	0-10	0-1.00	55.000	22.500	12.940	.665	550.000	1558.000	.409	.273	.013	10.000	3.633	.997
11	11-15	0-10	0-1.00	206.000	70.020	145.840	6.398	2585.000	9856.000	.340	.726	.032	12.549	3.813	.999
12	16-20	0-10	0-1.00	114.000	38.770	25.710	1.032	2011.000	7262.000	.340	.240	.010	17.640	3.611	.999
13	21-50	0-10	0-1.00	202.000	86.390	75.560	4.519	6311.000	21946.000	.428	.389	.023	31.243	3.477	.999
14	51-100	0-10	0-1.00	56.000	28.510	21.960	1.790	3966.000	14635.000	.509	.414	.034	70.821	3.690	.999
15	GT 100	0-10	0-1.00	37.000	12.560	8.380	.577	5401.000	20934.000	.339	.226	.016	145.973	3.876	.999
16	1	GT 10	0-1.00	248.000	67.660	598.570	14.930	248.000	12697.000	.273	2.558	.064	1.000	52.094	.001
17	2	GT 10	0-1.00	132.000	35.870	131.500	4.651	264.000	10823.000	.272	1.052	.037	2.000	40.996	.024
18	3	GT 10	0-1.00	94.000	16.810	38.984	1.089	282.000	10809.000	.179	.448	.013	3.000	38.330	.165
19	4	GT 10	0-1.00	54.000	10.460	3.420	.415	216.000	5705.000	.194	.063	.008	4.000	26.412	.474
20	5	GT 10	0-1.00	32.000	6.850	2.320	.381	160.000	5108.000	.214	.072	.012	5.000	31.925	.755
21	6	GT 10	0-1.00	30.000	6.230	1.700	.141	180.000	4861.000	.208	.057	.005	6.000	27.006	.899
22	7	GT 10	0-1.00	19.000	4.300	6.250	.247	133.000	7675.000	.226	.329	.013	7.000	57.707	.959
23	8	GT 10	0-1.00	15.000	2.550	1.330	.172	120.000	5416.000	.170	.089	.011	8.000	45.133	.983
24	9	GT 10	0-1.00	13.000	2.520	4.810	.229	117.000	2377.000	.194	.370	.018	9.000	20.316	.993
25	10	GT 10	0-1.00	13.000	2.380	.700	.064	130.000	8038.000	.183	.054	.005	10.000	61.831	.997
26	11-15	GT 10	0-1.00	48.000	9.140	15.620	.651	628.000	22360.000	.190	.332	.014	13.083	35.605	.999
27	16-20	GT 10	0-1.00	26.000	5.060	1.930	.195	474.000	12975.000	.195	.080	.008	18.231	27.373	.999
28	21-50	GT 10	0-1.00	40.000	7.800	18.870	.495	1248.000	25856.000	.195	.484	.013	31.200	20.718	.999
29	51-100	GT 10	0-1.00	12.000	4.310	28.420	.475	802.000	14641.000	.359	2.368	.040	66.833	18.256	.999
30	GT 100	GT 10	0-1.00	5.000	1.690	4.340	.106	688.000	19036.000	.338	.868	.021	137.600	27.669	.999
31	1	0-10	1.01-2.00	631.000	923.200	329.200	34.933	631.000	1430.000	1.463	.597	.063	1.000	2.266	.001
32	2	0-10	1.01-2.00	272.000	400.160	150.230	10.604	544.000	1247.000	1.471	.618	.044	2.000	2.292	.024
33	3	0-10	1.01-2.00	118.000	174.460	158.620	4.023	354.000	911.000	1.478	1.442	.037	3.000	2.573	.165
34	4	0-10	1.01-2.00	84.000	118.940	37.420	1.363	336.000	746.000	1.416	.527	.019	4.000	2.220	.474
35	5	0-10	1.01-2.00	41.000	61.380	20.080	1.211	205.000	486.000	1.497	.556	.034	5.000	2.371	.755
36	6	0-10	1.01-2.00	42.000	61.810	21.530	1.232	252.000	594.000	1.472	.552	.032	6.000	2.357	.899
37	7	0-10	1.01-2.00	38.000	54.100	31.560	1.883	266.000	821.000	1.424	.831	.050	7.000	3.086	.959
38	8	0-10	1.01-2.00	28.000	38.450	24.730	.732	224.000	788.000	1.373	.951	.028	8.000	3.518	.983
39	9	0-10	1.01-2.00	16.000	22.350	3.990	.104	144.000	523.000	1.397	.249	.006	9.000	3.632	.993
40	10	0-10	1.01-2.00	24.000	35.570	24.210	.642	240.000	741.000	1.482	1.153	.031	10.000	3.087	.997
41	11-15	0-10	1.01-2.00	52.000	76.930	72.800	3.812	677.000	2283.000	1.479	1.517	.079	13.019	3.372	.999
42	16-20	0-10	1.01-2.00	51.000	74.960	45.100	2.320	905.000	2737.000	1.470	.902	.046	17.745	3.024	.999
43	21-50	0-10	1.01-2.00	73.000	108.030	48.480	3.167	2291.000	6816.000	1.480	.746	.049	31.384	2.975	.999
44	51-100	0-10	1.01-2.00	32.000	47.750	26.580	1.856	2235.000	5139.000	1.480	1.022	.071	69.906	2.331	.999
45	GT 100	0-10	1.01-2.00	18.000	26.730	19.440	1.158	2684.000	8015.000	1.485	1.144	.074	149.111	2.986	.999
46	1	GT 10	1.01-2.00	46.000	66.720	40.070	1.090	46.000	2140.000	1.450	.932	.024	1.000	46.522	.001
47	2	GT 10	1.01-2.00	22.000	34.030	18.790	1.082	44.000	1516.000	1.547	.895	.052	2.000	34.455	.024
48	3	GT 10	1.01-2.00	8.000	11.810	3.120	.133	24.000	1084.000	1.476	.390	.017	3.000	45.167	.165
49	4	GT 10	1.01-2.00	4.000	5.590	.920	.249	16.000	1206.000	1.397	.230	.062	4.000	75.375	.474
50	5	GT 10	1.01-2.00	4.000	6.400	.610	.064	20.000	413.000	1.600	.152	.016	5.000	20.650	.755
51	6	GT 10	1.01-2.00	4.000	5.780	1.080	.054	24.000	500.000	1.445	.270	.014	6.000	20.833	.899
52	7	GT 10	1.01-2.00	3.000	4.110	2.210	.087	21.000	765.000	1.370	.737	.029	7.000	36.429	.959
54	9	GT 10	1.01-2.00	1.000	1.850	.250	.010	9.000	290.000	1.850	.250	.010	9.000	32.222	.993
55	10	GT 10	1.01-2.00	1.000	1.150	7.800	.095	10.000	120.000	1.150	7.800	.095	10.000	12.000	.997
56	11-15	GT 10	1.01-2.00	5.000	7.460	.920	.099	66.000	1066.000	1.492	.184	.020	13.200	16.152	.999

[a]Based on the probability that lines of this demand frequency will be stocked if stockage criteria are t-j.

Table B2 (cont)

DEMAND DATA FOR SPSM ANALYSIS - DIVISION C

Class structure					Totals for all FSNs in this class					Averages for FSNs in this class					Prob. of initial stockage, this class
Code	Demands Number	Demands Quantity	Unit price range	No. of FSNs	Unit price	Unit weight (lbs)	Unit cube, ft^3	Annual demands	Annual quantity demanded	Unit price	Unit weight (lbs)	Unit cube ft^3	Annual demands	Quantity per demand	
57	16-20	GT 10	1.01-2.00	3.000	3.760	3.530	.284	53.000	632.000	1.253	1.177	.095	17.667	11.925	.999
58	21-50	GT 10	1.01-2.00	9.000	15.270	11.230	.502	270.000	6537.000	1.697	1.404	.063	30.000	24.211	.999
60	GT 100	GT 10	1.01-2.00	3.000	4.320	6.270	.069	338.000	14041.000	1.440	3.135	.034	112.667	41.541	.999
61	1	0-10	2.01-3.00	363.000	909.110	342.700	22.744	363.000	794.000	2.504	1.150	.076	1.000	2.187	.001
62	2	0-10	2.01-3.00	157.000	391.350	92.310	4.965	314.000	651.000	2.493	.650	.035	2.000	2.073	.024
63	3	0-10	2.01-3.00	81.000	202.730	36.540	3.289	243.000	549.000	2.503	.522	.047	3.000	2.259	.165
64	4	0-10	2.01-3.00	53.000	128.440	40.110	4.587	212.000	542.000	2.423	.819	.094	4.000	2.557	.474
65	5	0-10	2.01-3.00	25.000	61.290	11.590	.806	125.000	229.000	2.452	.579	.040	5.000	1.832	.755
66	6	0-10	2.01-3.00	24.000	59.890	32.080	1.062	144.000	306.000	2.495	1.395	.046	6.000	2.125	.899
67	7	0-10	2.01-3.00	16.000	41.360	6.980	.391	112.000	268.000	2.585	.465	.026	7.000	2.393	.959
68	8	0-10	2.01-3.00	25.000	63.030	19.880	.989	200.000	511.000	2.521	.828	.041	8.000	2.555	.983
69	9	0-10	2.01-3.00	8.000	20.110	6.350	.705	72.000	125.000	2.514	.794	.088	9.000	1.736	.993
70	10	0-10	2.01-3.00	7.000	16.770	6.070	.275	70.000	153.000	2.396	.867	.039	10.000	2.186	.997
71	11-15	0-10	2.01-3.00	49.000	122.170	64.060	1.388	624.000	1776.000	2.493	1.490	.032	12.735	2.846	.999
72	16-20	0-10	2.01-3.00	22.000	55.080	17.450	.599	389.000	1192.000	2.504	.918	.032	17.682	3.064	.999
73	21-50	0-10	2.01-3.00	50.000	125.520	50.270	2.258	1512.000	4388.000	2.510	1.142	.051	30.240	2.902	.999
74	51-100	0-10	2.01-3.00	18.000	45.010	19.440	1.506	1216.000	2314.000	2.501	1.215	.094	67.556	1.903	.999
75	GT 100	0-10	2.01-3.00	12.000	29.540	30.750	1.983	1865.000	5334.000	2.462	2.562	.165	155.417	2.860	.999
76	1	GT 10	2.01-3.00	18.000	47.240	24.560	.633	18.000	1759.000	2.624	1.364	.035	1.000	97.722	.001
77	2	GT 10	2.01-3.00	11.000	24.750	26.150	.296	22.000	798.000	2.250	2.378	.027	2.000	36.273	.024
78	3	GT 10	2.01-3.00	3.000	7.970	.080	.012	9.000	340.000	2.657	.060	.006	3.000	37.778	.165
79	4	GT 10	2.01-3.00	1.000	2.110	.010	.310	4.000	51.000	2.110	.010	.010	4.000	12.750	.474
80	5	GT 10	2.01-3.00	1.000	2.750	.010	.001	5.000	85.000	2.750	.010	.001	5.000	17.000	.755
81	6	GT 10	2.01-3.00	3.000	7.980	1.270	.149	18.000	1003.000	2.660	.635	.074	6.000	55.722	.899
84	9	GT 10	2.01-3.00	3.000	7.350	6.120	.221	27.000	1085.000	2.450	2.040	.074	9.000	40.185	.993
85	10	GT 10	2.01-3.00	4.000	9.380	1.760	.033	40.000	658.000	2.345	.425	.008	10.000	16.450	.997
86	11-15	GT 10	2.01-3.00	3.000	8.170	.660	.024	40.000	610.000	2.723	.220	.008	13.333	15.250	.999
88	21-50	GT 10	2.01-3.00	4.000	8.980	11.420	.334	120.000	8984.000	2.245	2.855	.083	30.000	74.867	.999
89	51-100	GT 10	2.01-3.00	1.000	2.370	.840	.022	57.000	716.000	2.370	.840	.022	57.000	12.561	.999
91	1	0-10	3.01-4.00	277.000	968.070	179.630	12.574	277.000	571.000	3.495	.788	.055	1.000	2.061	.001
92	2	0-10	3.01-4.00	95.000	330.110	72.070	4.199	190.000	452.000	3.475	.848	.049	2.000	2.379	.024
93	3	0-10	3.01-4.00	53.000	186.970	53.610	2.746	159.000	308.000	3.520	1.161	.058	3.000	1.937	.165
94	4	0-10	3.01-4.00	37.000	131.090	35.220	.957	148.000	389.000	3.543	1.006	.027	4.000	2.628	.474
95	5	0-10	3.01-4.00	25.000	84.870	18.440	1.474	125.000	270.000	3.395	.719	.064	5.000	2.160	.755
96	6	0-10	3.01-4.00	27.000	96.210	33.250	1.360	162.000	396.000	3.563	1.511	.062	6.000	2.444	.899
97	7	0-10	3.01-4.00	16.000	55.460	13.360	.515	112.000	274.000	3.466	1.028	.040	7.000	2.446	.959
98	8	0-10	3.01-4.00	11.000	40.400	16.320	1.320	88.000	230.000	3.673	1.632	.132	8.000	2.614	.983
99	9	0-10	3.01-4.00	12.000	42.090	24.140	1.392	108.000	188.000	3.507	2.012	.116	9.000	1.741	.993
100	10	0-10	3.01-4.00	8.000	27.760	15.620	.878	80.000	187.000	3.470	1.952	.110	10.000	2.337	.997
101	11-15	0-10	3.01-4.00	35.000	120.310	94.520	2.582	446.000	960.000	3.437	2.956	.081	12.743	2.152	.999
102	16-20	0-10	3.01-4.00	16.000	54.820	18.780	.850	288.000	813.000	3.426	1.241	.061	18.000	2.823	.999
103	21-50	0-10	3.01-4.00	30.000	102.930	31.390	2.091	1068.000	2536.000	3.431	1.121	.075	35.600	2.375	.999
104	51-100	0-10	3.01-4.00	23.000	81.040	24.440	1.681	1565.000	3077.000	3.523	1.358	.093	68.043	1.966	.999
105	GT 100	0-10	3.01-4.00	11.000	37.920	12.620	.983	1610.000	3632.000	3.447	1.402	.109	146.364	2.256	.999
106	1	GT 10	3.01-4.00	11.000	39.370	10.850	1.353	11.000	476.000	3.579	.990	.123	1.000	43.273	.001
107	2	GT 10	3.01-4.00	4.000	13.790	7.070	.139	8.000	154.000	3.447	1.767	.035	2.000	19.250	.024
109	4	GT 10	3.01-4.00	2.000	6.220	.330	.024	8.000	125.000	3.110	.165	.012	4.000	15.625	.474
110	5	GT 10	3.01-4.00	1.000	3.970	1.100	.175	5.000	78.000	3.970	1.100	.175	5.000	15.600	.755
111	6	GT 10	3.01-4.00	1.000	3.480	.010	.001	6.000	79.000	3.480	.010	.001	6.000	13.167	.899
116	11-15	GT 10	3.01-4.00	2.000	7.080	.720	.094	25.000	300.000	3.540	.360	.047	12.500	12.000	.999
121	1	0-10	4.01-5.00	209.000	947.140	416.590	24.674	209.000	382.000	4.532	2.506	.153	1.000	1.828	.001
122	2	0-10	4.01-5.00	83.000	374.210	62.810	5.038	166.000	344.000	4.509	.966	.098	2.000	2.072	.024
123	3	0-10	4.01-5.00	39.000	177.580	31.360	1.592	117.000	208.000	4.551	.980	.090	3.000	1.778	.165

RAC

Table B2 (cont)

DEMAND DATA FOR SPSM ANALYSIS - DIVISION C

Class structure					Totals for all FSNs in this class					Averages for FSNs in this class					Prob. of initial stockage, this class
Code	Demands Number	Demands Quantity	Unit price range	No. of FSNs	Unit price	Unit weight (lbs)	Unit cube ft^3	Annual demands	Annual quantity demanded	Unit price	Unit weight (lbs)	Unit cube, ft^3	Annual demands	Quantity per demand	
124	4	0-10	4.01-5.00	38.000	167.340	29.800	1.491	152.000	409.000	4.404	.931	.047	4.000	2.691	.474
125	5	0-10	4.01-5.00	26.000	116.390	34.340	1.087	130.000	357.000	4.477	1.635	.090	5.000	2.746	.755
126	6	0-10	4.01-5.00	10.000	44.810	14.820	1.029	60.000	157.000	4.481	1.647	.101	6.000	2.617	.899
127	7	0-10	4.01-5.00	10.000	46.060	27.380	1.148	70.000	233.000	4.606	2.738	.115	7.000	3.329	.959
128	8	0-10	4.01-5.00	13.000	59.890	10.090	.936	104.000	350.000	4.607	.841	.078	8.000	3.365	.983
129	9	0-10	4.01-5.00	4.000	17.960	6.810	1.084	36.000	73.000	4.490	3.405	.542	9.000	2.028	.993
130	10	0-10	4.01-5.00	10.000	44.300	22.750	2.042	100.000	264.000	4.430	2.275	.204	10.000	2.640	.997
131	11-15	0-10	4.01-5.00	21.000	91.730	39.370	1.405	265.000	770.000	4.368	2.072	.074	12.619	2.906	.999
132	16-20	0-10	4.01-5.00	14.000	61.698	30.890	2.254	251.000	822.000	4.406	2.376	.173	17.929	3.275	.999
133	21-50	0-10	4.01-5.00	33.000	150.290	71.060	5.006	1019.000	2171.000	4.554	2.310	.161	30.879	2.131	.999
134	51-100	0-10	4.01-5.00	14.000	63.140	62.760	8.332	863.000	1582.000	4.510	4.483	.595	61.643	1.833	.999
135	GT 100	0-10	4.01-5.00	13.000	57.670	26.680	.934	1921.000	4384.000	4.436	2.223	.078	147.769	2.282	.999
136	1	GT 10	4.01-5.00	5.000	21.800	1.750	.096	5.000	90.000	4.360	.350	.019	1.000	18.000	.001
137	2	GT 10	4.01-5.00	4.000	17.690	1.230	.038	8.000	125.000	4.422	.307	.010	2.000	15.625	.024
138	3	GT 10	4.01-5.00	3.000	13.700	31.900	.746	9.000	328.000	4.567	10.633	.249	3.000	36.444	.165
139	4	GT 10	4.01-5.00	3.000	13.690	15.540	.222	12.000	195.000	4.563	5.180	.074	4.000	16.250	.474
144	9	GT 10	4.01-5.00	2.000	9.280	.790	.012	18.000	533.000	4.640	.395	.006	9.000	29.611	.993
146	11-15	GT 10	4.01-5.00	1.000	4.350	7.230	.058	15.000	203.000	4.350	7.230	.058	15.000	18.067	.999
147	16-20	GT 10	4.01-5.00	1.000	4.730	.140	.010	19.000	461.000	4.730	.140	.010	19.000	24.263	.999
148	21-50	GT 10	4.01-5.00	1.000	4.500	4.660	.092	30.000	979.000	4.500	4.660	.092	30.000	32.633	.959
149	51-100	GT 10	4.01-5.00	1.000	4.910	3.000	.132	63.000	760.000	4.910	3.000	.132	63.000	12.063	.999
151	1	0-10	5.01-6.00	188.000	1032.210	240.180	10.372	188.000	340.000	5.490	1.655	.069	1.000	1.051	.001
152	2	0-10	5.01-6.00	62.000	338.750	60.580	4.743	124.000	275.000	5.464	1.236	.097	2.000	2.218	.024
153	3	0-10	5.01-6.00	43.000	238.790	45.130	4.823	129.000	273.000	5.553	1.220	.130	3.000	2.116	.165
154	4	0-10	5.01-6.00	32.000	176.340	89.350	19.108	128.000	285.000	5.511	3.191	.682	4.000	2.227	.474
155	5	0-10	5.01-6.00	17.000	94.360	17.110	.738	85.000	208.000	5.551	1.141	.049	5.000	2.447	.755
156	6	0-10	5.01-6.00	15.000	83.320	33.670	2.565	90.000	229.000	5.555	2.808	.214	6.000	2.544	.899
157	7	0-10	5.01-6.00	18.000	97.770	11.500	.716	126.000	233.000	5.432	.885	.055	7.000	1.849	.959
158	8	0-10	5.01-6.00	5.000	27.410	2.310	.184	40.000	96.000	5.482	.577	.046	8.000	2.400	.983
159	9	0-10	5.01-6.00	4.000	21.770	6.790	.223	36.000	70.000	5.442	1.697	.056	9.000	1.944	.993
160	10	0-10	5.01-6.00	1.000	5.200	3.270	.001	10.000	11.000	5.200	3.270	.001	10.000	1.100	.997
161	11-15	0-10	5.01-6.00	16.000	84.360	27.960	2.706	206.000	510.000	5.272	1.997	.193	12.875	2.476	.999
162	16-20	0-10	5.01-6.00	18.000	96.840	31.000	1.101	327.000	798.000	5.380	1.871	.065	18.167	2.440	.999
163	21-50	0-10	5.01-6.00	22.000	119.240	62.110	2.745	725.000	1285.000	5.420	2.950	.131	32.955	1.772	.999
164	51-100	0-10	5.01-6.00	13.000	70.620	42.730	1.047	888.000	2481.000	5.432	3.287	.081	68.308	2.794	.999
165	GT 100	0-10	5.01-6.00	6.000	32.500	13.230	1.494	1012.000	1660.000	5.417	2.205	.249	168.667	1.640	.999
166	1	GT 10	5.01-6.00	5.000	27.630	2.930	1.321	5.000	113.000	5.526	.732	.330	1.000	22.600	.001
169	4	GT 10	5.01-6.00	2.000	10.350	3.030	.046	8.000	136.000	5.175	1.515	.023	4.000	17.000	.474
170	5	GT 10	5.01-6.00	2.000	10.750	.570	.012	10.000	257.000	5.375	.285	.006	5.000	25.700	.755
171	6	GT 10	5.01-6.00	1.000	5.140	.690	.107	6.000	66.000	5.140	.690	.107	6.000	11.000	.899
172	7	GT 10	5.01-6.00	1.000	5.960	6.450	.038	7.000	240.000	5.960	6.450	.038	7.000	34.286	.959
177	16-20	GT 10	5.01-6.00	1.000	5.980	.010	.001	17.000	251.000	5.980	.010	.001	17.000	14.765	.999
181	1	0-10	6.01-7.00	135.000	879.200	181.840	29.073	135.000	261.000	6.513	1.560	.251	1.000	1.933	.001
182	2	0-10	6.01-7.00	92.000	341.070	720.060	48.142	104.000	203.000	6.559	16.385	1.094	2.000	1.952	.024
183	3	0-10	6.01-7.00	25.000	164.630	23.810	.810	75.000	132.000	6.585	1.253	.043	3.000	1.760	.165
184	4	0-10	6.01-7.00	19.000	122.850	34.760	2.951	76.000	179.000	6.466	2.172	.184	4.000	2.355	.474
185	5	0-10	6.01-7.00	11.000	70.840	17.620	.612	55.000	139.000	6.440	1.702	.061	5.000	2.527	.755
186	6	0-10	6.01-7.00	11.000	72.040	46.830	3.137	66.000	154.000	6.549	5.203	.349	6.000	2.333	.899
187	7	0-10	6.01-7.00	2.000	13.060	8.690	.350	14.000	58.000	6.530	4.345	.175	7.000	4.143	.959
188	8	0-10	6.01-7.00	4.000	26.710	3.460	.205	32.000	71.000	6.677	1.153	.068	8.000	2.219	.983
189	9	0-10	6.01-7.00	4.000	26.320	15.190	1.316	36.000	86.000	6.580	7.595	.658	9.000	2.389	.993
190	10	0-10	6.01-7.00	6.000	39.220	4.720	.228	60.000	179.000	6.537	.944	.046	10.000	2.983	.997
191	11-15	0-10	6.01-7.00	15.000	97.290	38.110	2.587	191.000	364.000	6.486	3.176	.216	12.733	1.906	.959
192	16-20	0-10	6.01-7.00	7.000	45.400	26.350	3.215	123.000	350.000	6.486	3.764	.459	17.571	2.846	.999

RAC

Table B2 (cont)

DEMAND DATA FOR SPSM ANALYSIS - DIVISION C

Class structure					Totals for all FSNs in this class					Averages for FSNs in this class					Prob. of initial stockage, this class
Code	Demands Number	Demands Quantity	Unit price range	No. of FSNs	Unit price	Unit weight (lbs)	Unit cube, ft³	Annual demands	Annual quantity demanded	Unit price	Unit weight (lbs)	Unit cube ft³	Annual demands	Quantity per demand	
193	21-50	0-10	6.01-7.00	27.000	173.520	62.460	3.575	807.000	1472.000	6.427	2.602	.149	29.889	1.824	.999
194	51-100	0-10	6.01-7.00	11.000	74.600	33.450	1.381	819.000	2038.000	6.782	3.041	.126	74.455	2.488	.999
195	GT 100	0-10	6.01-7.00	2.000	12.900	73.750	6.600	296.000	637.000	6.450	36.875	3.300	148.000	2.152	.999
196	1	GT 10	6.01-7.00	7.000	44.790	14.940	.371	7.000	334.000	6.399	2.490	.062	1.000	47.714	.001
197	2	GT 10	6.01-7.00	1.000	6.200	16.810	1.040	2.000	101.000	6.200	16.810	1.040	2.000	50.500	.024
211	1	0-10	7.01-8.00	116.000	873.000	166.240	11.524	116.000	178.000	7.526	1.780	.124	1.000	1.534	.001
212	2	0-10	7.01-8.00	46.000	346.150	126.070	14.273	92.000	166.000	7.525	3.233	.366	2.000	1.804	.024
213	3	0-10	7.01-8.00	25.000	186.510	36.560	2.363	75.000	145.000	7.460	1.828	.118	3.000	1.933	.165
214	4	0-10	7.01-8.00	13.000	97.120	21.980	1.289	52.000	137.000	7.471	1.998	.117	4.000	2.635	.474
215	5	0-10	7.01-8.00	11.000	84.170	32.470	2.986	55.000	134.000	7.652	2.952	.271	5.000	2.436	.755
216	6	0-10	7.01-8.00	7.000	51.620	13.360	1.014	42.000	132.000	7.374	1.909	.145	6.000	3.143	.899
217	7	0-10	7.01-8.00	2.000	15.150	8.790	.111	14.000	50.000	7.575	4.395	.055	7.000	3.571	.959
218	8	0-10	7.01-8.00	3.000	22.060	25.780	1.596	24.000	30.000	7.353	8.593	.532	8.000	1.250	.983
219	9	0-10	7.01-8.00	3.000	22.310	6.440	.627	27.000	31.000	7.437	2.147	.209	9.000	1.148	.993
220	10	0-10	7.01-8.00	2.000	14.950	2.130	.167	20.000	88.000	7.475	1.065	.083	10.000	4.400	.997
221	11-15	0-10	7.01-8.00	16.000	121.900	79.620	3.895	205.000	512.000	7.619	5.087	.270	12.813	2.498	.999
222	16-20	0-10	7.01-8.00	10.000	73.030	34.970	2.439	183.000	366.000	7.303	3.497	.244	18.300	2.000	.999
223	21-50	0-10	7.01-8.00	8.000	59.180	17.140	.469	242.000	444.000	7.397	2.449	.067	30.250	1.835	.999
224	51-100	0-10	7.01-8.00	4.000	30.330	7.460	.168	287.000	789.000	7.582	1.865	.042	71.750	2.749	.999
225	GT 100	0-10	7.01-8.00	3.000	22.010	16.430	.765	394.000	889.000	7.337	5.477	.255	131.333	2.256	.999
226	1	GT 10	7.01-8.00	5.000	36.770	2.870	.132	5.000	88.000	7.354	.574	.026	1.000	17.600	.001
227	2	GT 10	7.01-8.00	1.000	7.150	.060	.001	2.000	23.000	7.150	.060	.001	2.000	11.500	.024
229	4	GT 10	7.01-8.00	2.000	14.490	.290	.033	8.000	96.000	7.245	.145	.016	4.000	12.000	.474
230	5	GT 10	7.01-8.00	1.000	7.960	.240	.014	5.000	254.000	7.960	.240	.014	5.000	50.800	.755
235	8	GT 10	7.01-8.00	1.000	7.200	.250	.016	8.000	93.000	7.200	.250	.016	8.000	11.625	.983
238	21-50	GT 10	7.01-8.00	1.000	7.470	.130	.015	33.000	613.000	7.470	.130	.015	33.000	18.576	.999
241	1	0-10	8.01-9.00	75.000	635.070	129.920	6.600	75.000	125.000	8.468	2.130	.108	1.000	1.667	.001
242	2	0-10	8.01-9.00	30.000	255.480	83.120	3.031	60.000	113.000	8.516	3.463	.126	2.000	1.883	.024
243	3	0-10	8.01-9.00	20.000	173.970	86.960	2.185	60.000	109.000	8.698	5.435	.137	3.000	1.817	.165
244	4	0-10	8.01-9.00	14.000	120.170	23.830	1.042	56.000	101.000	8.584	1.833	.080	4.000	1.804	.474
245	5	0-10	8.01-9.00	5.000	41.850	17.140	1.761	25.000	78.000	8.370	3.428	.352	5.000	3.120	.755
246	6	0-10	8.01-9.00	8.000	68.870	23.140	4.055	48.000	82.000	8.609	2.892	.507	6.000	1.708	.899
247	7	0-10	8.01-9.00	5.000	42.030	21.760	1.349	35.000	116.000	8.406	5.440	.337	7.000	3.314	.959
248	8	0-10	8.01-9.00	6.000	50.850	18.370	.372	48.000	97.000	8.475	3.062	.062	8.000	2.021	.983
249	9	0-10	8.01-9.00	2.000	17.350	1.290	.093	18.000	86.000	8.675	.645	.046	9.000	4.778	.993
250	10	0-10	8.01-9.00	5.000	42.140	18.190	.598	50.000	195.000	8.428	3.638	.120	10.000	3.900	.997
251	11-15	0-10	8.01-9.00	13.000	108.440	48.280	3.461	164.000	358.000	8.342	4.023	.288	12.615	2.183	.999
252	16-20	0-10	8.01-9.00	7.000	59.000	20.510	2.559	118.000	213.000	8.429	3.418	.426	16.857	1.805	.999
253	21-50	0-10	8.01-9.00	13.000	109.670	114.900	7.535	431.000	1116.000	8.436	8.838	.580	33.154	2.589	.999
254	51-100	0-10	8.01-9.00	1.000	8.770	2.000	.250	74.000	82.000	8.770	2.000	.250	74.000	1.108	.999
255	GT 100	0-10	8.01-9.00	3.000	24.540	10.330	.523	390.000	564.000	8.180	5.165	.261	130.000	1.446	.999
256	1	GT 10	8.01-9.00	2.000	17.530	1.840	.012	2.000	64.000	8.765	.920	.006	1.000	32.000	.001
260	5	GT 10	8.01-9.00	1.000	8.850	7.750	.069	5.000	59.000	8.850	7.750	.069	5.000	11.800	.755
261	6	GT 10	8.01-9.00	1.000	8.730	.900	.032	6.000	115.000	8.730	.900	.032	6.000	19.167	.899
264	9	GT 10	8.01-9.00	1.000	8.240	2.120	.220	9.000	266.000	8.240	2.120	.220	9.000	29.556	.993
265	10	GT 10	8.01-9.00	1.000	9.000	2.250	.043	10.000	146.000	9.000	2.250	.043	10.000	14.600	.997
271	1	0-10	9.01-10.00	96.000	917.370	330.700	75.174	96.000	210.000	9.556	4.409	1.002	1.000	2.188	.001
272	2	0-10	9.01-10.00	32.000	308.320	72.020	10.107	64.000	105.000	9.635	2.687	.374	2.000	1.641	.024
273	3	0-10	9.01-10.00	23.000	220.400	73.690	3.833	69.000	188.000	9.583	4.335	.178	3.000	2.725	.165
274	4	0-10	9.01-10.00	22.000	211.300	71.300	5.980	88.000	163.000	9.605	3.961	.332	4.000	1.852	.474
275	5	0-10	9.01-10.00	9.000	85.460	32.000	1.355	45.000	109.000	9.496	4.000	.169	5.000	2.422	.755
276	6	0-10	9.01-10.00	6.000	56.940	18.570	.444	36.000	77.000	9.490	3.714	.089	6.000	2.139	.899
277	7	0-10	9.01-10.00	3.000	27.950	5.890	.336	21.000	30.000	9.317	1.963	.112	7.000	1.429	.959
278	8	0-10	9.01-10.00	3.000	28.640	20.580	1.125	24.000	45.000	9.547	6.860	.375	8.000	1.875	.983

Table B2 (cont)

DEMAND DATA FOR SPSM ANALYSIS - DIVISION C

Code	Class structure: Demands Number	Class structure: Demands Quantity	Class structure: Unit price range	No. of FSNs	Totals for all FSNs in this class: Unit price	Totals: Unit weight (lbs)	Totals: Unit cube ft3	Totals: Annual demands	Totals: Annual quantity demanded	Averages for FSNs in this class: Unit price	Averages: Unit weight (lbs)	Averages: Unit cube, ft3	Averages: Annual demands	Averages: Quantity per demand	Prob. of initial stockage, this class
279	9	0-10	9.01-10.00	2.000	19.870	10.000	1.061	18.000	94.000	9.935	10.000	1.061	9.000	5.222	.993
280	10	0-10	9.01-10.00	3.000	28.390	18.220	.929	30.000	82.000	9.463	9.110	.464	10.000	2.733	.997
281	11-15	0-10	9.01-10.00	7.000	66.390	21.350	2.402	95.000	116.000	9.484	4.270	.498	13.571	1.221	.999
282	16-20	0-10	9.01-10.00	5.000	47.000	25.590	.618	87.000	201.000	9.400	6.397	.154	17.400	2.310	.999
283	21-50	0-10	9.01-10.00	10.000	95.490	37.290	1.349	324.000	483.000	9.549	5.327	.193	32.400	1.491	.999
284	51-100	0-10	9.01-10.00	2.000	19.100	16.980	1.742	133.000	208.000	9.550	8.490	.871	66.500	1.564	.999
285	GT 100	0-10	9.01-10.00	2.000	19.300	9.250	.528	271.000	311.000	9.650	4.625	.264	135.500	1.148	.979
286	1	GT 10	9.01-10.00	2.000	18.980	11.200	.377	2.000	120.000	9.490	5.600	.188	1.000	60.000	.001
287	2	GT 10	9.01-10.00	1.000	9.400	.240	.003	2.000	26.000	9.400	.240	.003	2.000	13.000	.024
301	1	0-10	GT 10.00	1560.000	301102.910	74984.400	4045.000	1560.000	2803.000	193.015	64.642	3.407	1.000	1.797	.001
302	2	0-10	GT 10.00	539.000	45098.000	11207.930	417.748	1076.000	1965.000	83.825	26.686	.995	2.000	1.826	.024
303	3	0-10	GT 10.00	276.000	18355.140	8227.986	231.330	828.000	1487.000	66.504	29.799	1.107	3.000	1.796	.185
304	4	0-10	GT 10.00	170.000	15141.870	4144.670	121.158	[illegible]	1428.000	89.070	32.635	.954	4.000	2.100	.474
305	5	0-10	GT 10.00	131.000	7297.900	2612.230	100.095	655.000	1441.000	55.694	25.610	.981	5.000	2.200	.755
306	6	0-10	GT 10.00	79.000	3086.150	467.770	25.352	474.000	1064.000	39.065	8.662	.469	6.000	2.245	.899
307	7	0-10	GT 10.00	72.000	4265.630	1014.430	50.333	504.000	1332.000	59.245	31.832	.700	7.000	2.643	.959
308	8	0-10	GT 10.00	54.000	2415.830	658.990	49.979	432.000	942.000	44.738	15.690	1.190	8.000	2.181	.983
309	9	0-10	GT 10.00	47.000	3607.530	1037.580	32.705	423.000	815.000	76.756	25.307	.798	9.000	1.927	.993
310	10	0-10	GT 10.00	31.000	995.910	435.230	17.611	310.000	585.000	32.126	16.740	.677	10.000	1.887	.997
311	11-[illegible]	0-10	GT 10.00	104.000	3720.950	1040.540	52.174	1321.000	2833.000	35.778	12.099	.607	12.702	2.145	.999
312	[illegible]-20	0-10	GT 10.00	74.000	2629.130	857.180	37.264	1324.000	2670.000	35.529	14.528	.632	17.892	2.017	.999
313	21-50	0-10	GT 10.00	134.000	4251.310	2052.720	85.094	4035.000	8622.000	31.726	20.527	.861	30.112	2.137	.999
314	51-100	0-10	GT 10.00	39.000	962.970	468.510	24.733	2636.000	5896.000	24.692	13.014	.687	67.590	2.237	.999
315	GT 100	0-10	GT 10.00	13.000	205.740	134.520	7.389	1797.000	3753.000	15.826	13.452	.739	138.231	2.088	.999
316	1	GT 10	GT 10.00	47.000	3868.740	962.810	25.956	47.000	2464.000	82.314	17.055	.787	1.000	52.426	.001
317	2	GT 10	GT 10.00	7.000	261.900	54.440	2.287	14.000	464.030	37.414	9.073	.381	2.000	33.143	.024
318	3	GT 10	GT 10.00	5.000	131.860	1.370	.074	15.000	259.000	26.372	.342	.018	3.000	17.267	.185
319	4	GT 10	GT 10.00	4.000	350.630	55.490	1.184	16.000	638.000	87.657	13.873	.296	4.000	39.875	.474
321	6	GT 10	GT 10.00	3.000	116.210	71.000	1.503	18.000	1318.000	38.737	35.500	.752	6.000	73.222	.899
322	7	GT 10	GT 10.00	1.000	20.620	35.000	4.260	7.000	169.000	20.620	35.000	4.260	7.000	24.143	.959
323	8	GT 10	GT 10.00	1.000	134.000	450.000	5.692	8.000	361.000	134.000	450.000	5.692	8.000	45.125	.983
324	9	GT 10	GT 10.00	1.000	10.400	.900	.032	9.000	113.000	10.400	.902	.032	9.000	12.556	.993
325	10	GT 10	GT 10.00	5.000	182.120	7.410	7.563	50.000	911.000	36.424	1.852	1.891	10.000	18.220	.997
326	11-15	GT 10	GT 10.00	4.000	125.300	7.770	.158	53.000	1461.000	31.325	2.590	.053	13.250	27.566	.999
327	16-20	GT 10	GT 10.00	4.000	144.390	242.710	23.535	77.000	5192.000	36.097	60.677	5.884	19.250	67.429	.999
328	21-50	GT 10	GT 10.00	3.000	88.580	133.210	12.201	81.000	5657.000	29.527	44.403	4.067	27.000	69.840	.999
329	51-100	GT 10	GT 10.00	4.000	170.910	147.700	2.214	242.000	12156.000	42.727	49.233	.738	60.500	50.231	.999

Table B3

OST DATA DISTRIBUTION USED IN SPSM

Days required for fill from CONUS	Cumulative percent
26	2
30	7
34	15
38	25
40	30
46	42
50	50
54	56
60	64
66	70
70	74
79	80
92	86
140	95
400	100

Table 9A

DETAILED OUTPUT OF SPIN RUNS, DIVISION A
FOR ALTERNATIVE [illegible] POLICIES

Random Number = 19

Stockage Depth Policy - N = .40, C = $10 (current Army policy)

Measure	Addition-Retention Criteria											
	13-8	14-7	22-2	18-4	19-3	19-1	15-4	16-2	14-3	16-0	14-1	10-3
Demand Accommodation, %	65	65	65	65	66	70	70	70	70	70	75	75
Demand Satisfaction, %	63	76	73	62	63	74	71	66	71	64	69	65
ASL Size	2,415	2,427	2,432	2,447	2,534	3,039	3,060	3,[illegible]22	3,144	3,149	3,860	3,910
ASL Turbulence, %	11	6	<1	<1	<1	<1	2	<1	1	13	<1	3
Tech supply fill rate, %	41.0	49.5	47.2	40.2	41.8	51.2	49.8	46.5	49.5	44.7	51.6	48.9
Tech supply quantity fill rate, %	39.7	48.3	46.3	39.6	41.2	51.1	48.3	45.5	48.3	44.4	51.8	47.5
Avg wait, days	35.0	28.7	29.0	33.6	32.6	25.4	26.9	30.9	28.7	29.0	23.9	25.9
Number parts shortages (annual)	345,015	307,154	332,141	358,713	347,007	294,082	326,114	322,911	306,593	336,293	295,191	324,190
Part-days of shortage (annual)	20,127,299	16,973,340	17,757,243	20,154,676	19,390,708	15,250,586	16,844,959	18,205,617	16,954,019	17,860,444	14,866,240	16,748,095
Avg duration of shortage, days	58.3	55.3	53.5	56.2	55.9	51.9	51.7	56.6	55.2	53.1	50.4	51.7
Percent of days with dues-out	28.1	23.8	27.0	27.7	27.0	23.5	24.4	25.2	23.8	26.4	21.7	23.7
Avg inventory (parts)	32,858	44,920	37,614	33,982	36,052	26,805	43,500	43,065	45,058	41,947	49,445	47,422
Avg age of inventory, days	51	56	48	52	53	55	52	52	56	55	56	58
Zero balance, %	31.3	28.3	26.5	33.5	32.7	24.1	30.7	29.3	26.2	33.9	24.5	31.4
Percent of zero balance time during which dues-out are recorded (total sim. time)	30.5	27.4	29.7	30.2	29.7	27.8	27.9	28.8	27.4	29.9	26.2	28.1
Percent of zero balance time during which dues-out are recorded (time on list)	96.9	94.5	97.5	97.3	97.3	96.9	92.1	94.6	94.5	97.6	91.6	96.8
Zero balance with dues-out, %	9.5	7.8	7.9	10.1	9.7	6.6	8.6	8.4	7.7	10.1	6.4	8.8
Number demands (annual)	102,778	105,713	107,009	106,323	105,896	105,624	107,104	105,632	105,442	108,644	109,773	108,764
Quantity demanded (annual)	575,657	590,801	612,458	599,164	594,981	601,575	626,292	591,652	590,952	616,967	622,779	621,609
Avg Quantity/demand	5.60	5.59	5.72	5.64	5.62	5.70	5.85	5.60	5.59	5.68	5.69	5.72
Number replenishment orders (annual)	48,036	39,450	45,676	47,005	44,990	39,471	39,517	42,921	39,450	42,855	37,269	38,448
Total replenishment quantity (annual)	576,258	590,735	611,963	600,252	596,370	602,963	627,021	591,653	590,902	617,396	621,827	623,627
Avg quantity/order	12.0	15.0	13.4	12.8	13.3	15.3	15.8	13.8	15.0	14.4	16.7	16.2
Quantity received (annual)	572,879	590,911	616,917	596,432	592,349	600,400	629,220	595,133	596,107	611,426	615,664	621,473
Avg inventory value, $	368,057	557,724	435,291	398,736	433,082	583,551	540,689	473,370	563,522	525,542	714,610	673,011
Avg inventory weight, lbs	240,397	343,465	282,683	259,433	281,923	367,931	336,209	301,550	344,513	345,110	391,247	363,663
Avg inventory cube, cu.ft	11,715	15,366	13,388	12,078	12,875	16,408	15,264	13,784	15,427	14,319	17,377	16,151
Avg holding cost/year	220,834	334,534	261,175	239,242	259,849	350,119	324,414	284,022	338,113	315,325	428,766	403,806
Avg ordering cost/year	960,720	789,004	913,524	940,096	899,800	789,420	736,340	858,016	789,592	857,108	745,384	768,156
Avg shortage cost/year	20,127,299	16,973,320	17,757,243	20,154,676	19,390,700	15,250,506	16,844,959	18,205,621	16,954,019	17,860,444	14,866,240	16,748,095
Avg shortage weight/year	2,447,847	2,039,582	2,285,448	2,469,791	2,343,935	1,909,420	2,268,390	2,185,446	2,039,904	2,356,815	[illegible]	[illegible]
Avg shortage cube/year	110,230	93,825	102,995	110,764	106,200	90,493	100,739	99,216	93,767	109,458	91,779	105,843
Avg parts value/demand	137	136	140	138	137	139	143	137	137	139	139	[illegible]
Avg weight/demand	45	45	46	45	45	45	47	45	45	[illegible]	45	[illegible]
Avg cube/demand	1.922	1.918	1.964	1.934	1.928	1.955	2.007	1.922	1.919	[illegible]	1.974	1.961
Avg parts value/order	293	346	327	312	324	373	385	337	366	[illegible]	437	397
Avg weight/order	96	120	107	102	106	122	126	110	119	[illegible]	133	[illegible]
Avg cube/order	4.117	5.139	4.598	4.383	4.549	5.243	[illegible]	4.731	5.137	[illegible]	[illegible]	[illegible]
Avg time between arrival and demand	15	-2	7	23	11	-3	[illegible]	[illegible]	2	5	-5	[illegible]
Closing inventory (parts)	25,174	57,709	39,134	24,705	24,927	39,914	53,173	51,746	57,879	49,522	64,548	66,161
Closing dues-out quantity	50,869	20,957	15,544	48,466	47,323	20,333	18,497	27,757	[illegible]	59,439	32,168	[illegible]
Closing dues-in quantity	123,189	87,082	74,045	127,721	131,096	100,130	71,909	90,477	86,641	[illegible]	[illegible]	[illegible]
Pipeline quantity	97,494	123,834	97,637	103,960	108,700	118,711	106,665	114,466	123,753	118,134	[illegible]	131,314
Pipeline value, $	109,297	153,752	112,941	123,984	130,578	148,000	132,581	135,242	154,773	140,007	151,352	156,366
NORS factor = [(1-quantity fill rate) x avg duration of shortage]	.352	.286	.227	.339	.329	.254	.267	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Estimated NORS	.086	.071	.071	.084	.081	.062	.067	.076	.071	[illegible]	[illegible]	[illegible]

RAC

Table [illegible] (continued)

DETAILED OUTPUT OF [illegible] RUNS, DIVISION A

Measure	Addition-Retention Criteria										
	11-2	8-4	6-3	9-1	5-4	7-2	5-2	6-1	3-3	3-1	2-2
Demand Accommodation, %	76	75	80	81	50	[illegible]	84	85	85	91	90
Demand Satisfaction, %	69	73	71	67	67	66	71	72	70	70	70
ASL Size	4,057	4,106	5,284	5,304	5,360	5,397	6,558	6,935	7,959	10,903	11,116
ASL Turbulence, %	2	11	25	1	32	5	13	4	51	19	53
Tech supply fill rate, %	52.6	54.6	57.1	54.6	53.4	53.4	59.6	61.2	59.2	64.0	62.7
Tech supply quantity fill rate, %	50.3	52.9	50.9	51.0	53.3	51.1	58.5	59.6	56.7	61.9	61.6
Avg wait, days	26.6	21.0	21.4	21.4	19.5	22.0	17.2	15.6	17.2	14.0	15.4
Number parts shortages (annual)	290,589	284,746	317,478	286,260	268,075	[illegible]31,848	267,628	240,271	246,716	226,824	221,925
Part-days of shortage (annual)	15,682,182	13,024,589	14,813,399	12,911,567	11,479,664	[illegible]	10,404,364	9,406,417	10,075,544	8,469,048	9,282,060
Avg duration of shortage, days	54.0	45.7	46.7	45.1	42.8	45.3	42.0	39.5	40.9	37.4	40.0
Percent of days with dues-out	21.7	21.4	22.1	18.5	22.4	19.7	20.8	18.8	18.5	14.8	16.7
Avg inventory (parts)	55,255	54,822	67,254	61,101	57,711	58,767	67,665	72,056	71,413	85,417	81,675
Avg age of inventory, days	67	61	72	72	69	67	71	75	80	84	82
Zero balance, %	24.8	25.6	23.1	23.8	23.3	27.5	24.8	21.0	18.9	16.4	18.5
Percent of zero balance time during which dues-out are recorded (total sim. time)	26.4	26.1	28.9	24.2	29.4	25.4	29.1	27.4	28.9	29.[illegible]	32.6
Percent of zero balance time during which dues-out are recorded (time on list)	94.7	93.9	89.0	89.3	88.2	90.8	85.8	82.7	85.1	81.9	84.3
Zero balance with dues-out, %	6.5	6.7	6.7	5.7	6.9	7.0	1.2	5.8	5.5	4.8	6.0
Number demands (annual)	105,500	109,739	105,311	104,548	103,865	108,003	105,621	107,795	103,287	107,706	105,475
Quantity demanded (annual)	588,803	620,553	693,765	602,305	588,408	626,944	606,649	607,179	586,343	605,992	603,022
Avg quantity/demand	5.58	5.65	6.59	5.74	5.67	5.80	5.74	5.63	5.68	5.63	5.72
Number replenishment orders (annual)	36,413	37,491	34,115	33,154	34,337	34,035	32,956	33,465	32,636	32,364	31,879
Total replenishment quantity (annual)	587,979	618,548	691,019	600,602	585,434	625,091	604,996	610,210	584,622	608,962	601,358
Avg quantity/order	16.2	16.5	20.3	18.1	17.2	18.4	18.4	18.3	18.1	18.8	18.9
Quantity received (annual)	589,693	615,333	672,809	589,808	576,655	620,318	603,672	602,611	571,559	661,552	606,257
Avg inventory value, $	820,708	778,408	991,996	943,548	876,461	891,476	1,020,616	1,091,978	1,058,409	1,393,726	1,251,032
Avg inventory weight, lbs	456,461	432,045	502,869	477,353	446,609	435,312	507,768	549,179	517,119	619,343	579,350
Avg inventory cube, cu.ft.	19,984	19,130	22,512	20,968	18,796	19,459	22,637	24,456	23,190	27,337	25,770
Avg holding cost/year	492,425	467,045	396,762	566,129	525,877	534,880	612,370	655,187	635,[illegible]	752,236	750,619
Avg ordering cost/year	728,256	749,825	341,154	663,084	686,736	680,704	659,129	665,292	652,726	647,276	637,572
Avg shortage cost/year	15,682,182	13,024,589	14,813,399	12,911,567	11,479,664	13,762,290	10,404,364	9,406,417	10,075,544	[illegible]	9,282,060
Avg shortage weight/year	1,870,898	1,837,060	2,009,094	1,594,935	1,819,449	2,139,846	1,677,822	1,554,877	1,656,221	1,497,236	1,616,221
Avg shortage cube/year	87,644	86,506	107,318	89,306	98,554	100,[illegible]60	81,094	75,402	85,45[illegible]	73,231	78,542
Avg parts value/demand	135	139	16[illegible]	140	138	142	140	138	139	13[illegible]	[illegible]
Avg weight/demand	45	45	53	46	45	46	46	45	45	45	46
Avg cube/demand	1.915	1.942	2.261	1.972	1.944	1.992	1.976	1.933	1.960	[illegible]	1.962
Avg parts value/order	394	403	495	442	419	449	448	448	441	[illegible]	461
Avg weight/order	129	132	162	144	137	147	146	146	144	15[illegible]	151
Avg cube/order	5.542	5.662	6.952	6.211	5.892	6.313	6.246	6.276	6.201	[illegible]	[illegible]
Avg time between arrival and demand	.7	.11	.15	.16	.17	.12	.25	.29	.29	.59	.3[illegible]
Closing inventory (parts)	56,738	61,421	88,455	52,643	51,528	43,308	90,972	74,313	56,252	[illegible]	101,96[illegible]
Closing dues-out quantity	37,112	58,199	137,276	59,295	40,900	41,025	29,441	31,334	46,013	[illegible]	23,69[illegible]
Closing dues-in quantity	103,475	125,313	191,328	127,599	128,940	133,896	83,550	117,706	144,195	116,1[illegible]	[illegible]
Pipeline quantity	133,102	129,035	142,567	127,947	139,568	136,159	145,061	156,525	154,435	[illegible]	161,[illegible]
Pipeline value, $	197,695	183,215	210,179	197,581	231,963	206,594	218,501	237,141	235,374	[illegible]	[illegible]
NORS factor = [(1-quantity fill rate) x avg duration of shortage]	.268	.215	.229	.221	.200	.222	.174	.160	.1[illegible]	.14[illegible]	.1[illegible]
Estimated NORS	.067	.054	.057	.054	.050	.054	.044	.039	.044	.035	[illegible]

Table 85

DETAILED OUTPUT OF SPEM RUNS, DIVISION C
FOR ALTERNATIVE [illegible] POLICIES

Random Number = 19

Stockage Depth Policy - K = .40, C = $10 (current Army policy)

Measure	Addition-Retention Criteria											
	13-8	14-7	22-2	18-4	19-3	19-1	13-4	16-2	14-3	16-6	14-1	10-3
Demand Accommodation, %	69	69	69	69	70	73	73	74	74	73	77	77
Demand Satisfaction, %	77	79	75	75	73	77	80	76	80	78	79	76
ASL Size	2,106	2,115	2,122	2,132	2,139	2,579	2,600	2,646	2,665	2,673	3,233	3,271
ASL Turbulence, %	10	5	<1	<1	<1	<1	2	<1	1	12	<1	3
Tech supply fill rate, %	52.8	54.3	51.8	51.5	51.4	56.2	58.6	56.0	59.9	56.7	60.7	58.7
Tech supply quantity fill rate, %	49.0	50.5	50.9	48.9	49.5	56.6	53.9	54.5	54.9	53.6	60.1	57.0
Avg wait, days	26.7	26.2	26.2	28.5	28.1	20.8	24.7	25.8	24.0	25.1	19.2	21.9
Number parts shortages (annual)	280,184	266,159	241,209	272,690	271,513	220,354	254,282	241,918	246,241	231,573	198,911	219,302
Part-days of shortage (annual)	14,572,067	14,290,697	13,098,166	15,087,754	14,992,448	10,570,908	13,553,239	13,196,595	13,102,279	12,771,382	9,886,220	11,183,705
Avg duration of shortage, days	52.0	53.7	54.3	55.3	55.2	48.0	53.3	54.6	53.2	55.2	49.5	51.0
Percent of days with dues-out	27.9	29.2	27.8	30.0	28.3	25.9	25.4	26.2	26.5	25.7	22.4	24.4
Avg inventory (parts)	53,146	55,643	53,050	52,224	52,872	59,74.	61,535	60,569	63,372	63,297	70,405	67,718
Avg age of inventory, days	73	73	76	72	71	5	75	78	76	85	82	85
Zero balance, %	23.0	19.9	20.7	21.6	22.4	20.0	19.4	19.9	19.2	19.3	17.7	20.1
Percent of zero balance time during which dues-out are recorded (total sim. time)	31.4	33.0	31.4	33.8	32.0	30.1	29.6	30.6	28.7	30.0	27.3	29.6
Percent of zero balance time during which dues-out are recorded (time on list)	52.4	91.8	95.0	94.5	96.2	93.0	91.5	89.0	90.2	91.1	88.2	90.0
Zero balance with dues-out, %	7.2	6.6	6.5	7.3	7.2	6.0	5.7	6.1	5.5	5.8	4.8	6.0
Number demands (annual)	98,769	98,732	98,053	99,167	99,719	100,681	97,843	99,574	96,665	99,444	97,545	98,008
Quantity demanded (annual)	545,346	545,117	500,561	529,621	532,709	509,267	549,071	531,552	546,470	507,949	515,530	511,631
Avg quantity/demand	5.52	5.52	5.10	5.33	5.34	5.06	5.61	5.34	5.65	5.11	5.29	5.22
Number replenishment orders (annual)	35,175	35,568	35,548	35,768	35,948	33,383	32,528	33,017	31,308	32,769	28,967	30,517
Total replenishment quantity (annual)	546,155	539,354	501,977	527,524	531,678	509,667	549,107	526,920	547,642	510,69[illegible]	512,343	512,221
Avg quantity/order	15.5	15.2	14.0	14.8	14.8	15.3	16.9	16.0	17.5	15.6	17.7	16.5
Quantity received (annual)	547,834	539,144	496,465	534,727	539,235	507,979	546,906	526,044	545,198	505,784	512,622	510,791
Avg inventory value, $	180,987	189,586	182,144	198,095	196,082	206,733	217,586	232,295	226,541	209,401	262,753	250,507
Avg inventory weight, lbs	109,940	117,455	111,810	120,161	118,796	121,961	128,724	134,359	132,055	122,083	147,423	146,096
Avg inventory cube, cu.ft.	5,702	6,077	5,838	6,133	6,150	6,303	6,500	6,765	6,736	6,257	7,724	6,[illegible]
Avg holding cost/year	72,395	75,834	72,858	79,236	78,433	82,693	87,034	92,918	90,61[illegible]	[illegible]	[illegible]	[illegible]
Avg ordering cost/year	351,750	355,680	358,482	357,676	359,484	333,832	325,184	330,132	313,084	327,608	289,672	305,172
Avg shortage cost/year	14,572,067	14,290,697	13,098,166	15,087,754	14,992,448	10,570,908	13,553,239	13,196,595	13,102,279	12,771,382	9,886,220	11,183,705
Avg shortage weight/year	1,146,204	1,238,697	1,200,407	1,060,208	1,234,862	1,236,914	1,043,074	1,112,738	985,517	1,259,155	1,191,918	990,433
Avg shortage cube/year	49,566	57,090	51,634	49,474	57,290	57,019	45,302	50,265	42,034	56,532	56,206	43,537
Avg parts value/demand	166	166	153	160	161	152	169	164	170	153	159	157
Avg weight/demand	59	59	55	57	57	54	60	57	61	55	57	56
Avg cube/demand	3.040	3.040	2.811	2.938	2.942	2.785	3.090	2.946	3.113	2.813	2.914	2.875
Avg parts value/order	467	456	421	443	444	459	508	450	545	449	531	503
Avg weight/order	167	163	150	158	159	164	181	171	187	167	196	17[illegible]
Avg cube/order	8.559	8.350	7.711	8.121	8.144	8.407	9.302	8.789	9.632	8.585	9.739	9.224
Avg time between arrival and demand	-9	-11	-13	-7	-7	-23	-16	-17	-15	-21	-35	-27
Closing inventory (parts)	68,515	42,472	59,735	57,103	57,838	66,408	63,074	61,767	68,345	56,236	[illegible]	63,[illegible]
Closing dues-out quantity	24,172	34,433	46,456	32,333	32,348	28,509	21,772	24,923	23,806	46,159	37,352	37,2[illegible]
Closing dues-in quantity	79,134	94,662	101,050	93,666	91,864	85,667	75,513	68,580	78,239	127,149	106,086	115,636
Pipeline quantity	123,477	102,902	114,329	115,436	118,374	123,566	116,815	105,424	122,799	135,191	132,442	141,211
Pipeline value, $	420,501	350,604	392,251	437,860	439,018	427,575	413,034	404,322	435,952	447,396	494,256	522,356
ZCRS factor = [(1-quantity fill rate) x avg duration of shortage]	.265	.266	.267	.283	.2[illegible]	.208	.246	.248	.240	.256	.198	.219
Estimated ZCRS	.067	.067	.067	.071	.070	.053	.062	.063	.061	.065	.05[illegible]	.05[illegible]

RAC

Table 85 (continued)

DETAILED OUTPUT OF SPEM RUNS, DIVISION C

Measure	Addition-Retention Criteria										
	11-7	8-4	6-3	9-1	5-4	7-2	5-2	6-1	3-3	3-1	2-2
Demand Accommodation, %	78	78	82	83	82	83	86	87	87	92	91
Demand Satisfaction, %	79	73	79	75	77	77	78	77	74	76	73
ASL Size	3,356	3,427	4,379	4,388	4,449	4,467	5,452	5,734	6,575	8,995	9,120
ASL Turbulence, %	1	11	14	1	31	5	13	4	51	18	52
Tech supply fill rate, %	60.7	56.6	63.6	62.7	63.0	64.3	67.3	67.3	64.7	69.9	71.2
Tech supply quantity fill rate, %	60.7	54.5	61.4	61.1	62.4	61.9	66.0	64.7	63.6	68.4	70.9
Avg wait, days	19.0	24.8	20.1	20.1	18.3	20.0	16.6	16.5	17.0	14.4	13.6
Number parts shortages (annual)	197,050	228,143	199,985	205,946	195,737	194,155	172,384	188,233	188,542	161,779	153,995
Part-days of shortage (annual)	9,896,385	12,726,342	10,290,688	10,624,892	9,490,011	10,110,239	8,496,695	8,628,534	8,892,535	7,389,053	6,977,739
Avg duration of shortage, days	50.2	55.8	51.5	51.6	48.5	52.1	47.6	46.	47.2	45.7	45.3
Percent of days with dues-out	22.8	25.0	21.1	20.9	21.3	21.4	18.6	18.2	18.4	12.9	14.5
Avg inventory (parts)	71,333	67,365	79,212	77,944	79,735	80,145	89,560	90,090	93,556	107,673	109,415
Avg age of inventory, days	82	87	92	88	90	92	94	94	100	110	104
Zero balance, %	20.0	20.2	16.7	19.0	16.8	17.1	17.4	17.6	17.5	16.0	13.9
Percent of zero balance time during which dues-out are recorded (total sim. time)	27.9	30.6	27.9	27.5	28.4	28.5	26.6	27.2	28.8	25.5	29.6
Percent of zero balance time during which dues-out are recorded (time on list)	89.7	91.5	87.8	87.7	85.9	87.0	84.5	85.2	81.5	83.1	80.3
Zero balance with dues-out, %	5.6	6.2	4.7	5.3	4.8	4.9	4.6	4.8	5.0	4.1	4.1
Number demands (annual)	97,681	100,574	98,921	99,227	98,299	97,671	98,880	100,394	100,681	97,958	100,233
Quantity demanded (annual)	520,754	512,353	510,842	528,963	519,826	505,728	513,357	536,468	522,205	511,979	513,923
Avg quantity/demand	5.33	5.09	5.16	5.33	5.29	5.18	5.19	5.34	5.19	5.23	5.13
Number replenishment orders (annual)	28,296	31,454	27,571	26,823	28,698	26,551	24,944	24,907	25,868	21,326	23,505
Total replenishment quantity (annual)	517,623	514,106	510,836	525,688	517,075	507,125	508,300	535,645	525,256	510,044	514,654
Avg quantity/order	18.3	16.3	18.5	19.6	18.0	19.1	20.4	21.5	20.3	23.9	21.7
Quantity received (annual)	515,130	508,754	509,358	531,436	516,521	503,383	519,541	541,377	524,237	510,219	520,865
Avg inventory value, $	242,170	255,068	325,288	304,277	322,317	318,558	358,939	361,190	461,635	437,027	508,320
Avg inventory weight, lbs	136,410	144,301	178,026	160,928	173,425	171,699	192,511	185,739	200,958	236,559	245,083
Avg inventory cube, cu.ft.	6,743	7,017	8,391	7,778	8,258	8,198	8,925	8,731	9,519	10,952	11,734
Avg holding cost/year	96,868	102,027	130,115	121,712	128,927	127,423	147,575	144,476	160,654	198,835	203,328
Avg ordering cost/year	282,956	314,542	275,710	268,228	286,976	265,510	249,436	249,066	258,676	213,264	235,052
Avg shortage cost/year	9,896,385	12,726,342	10,290,688	10,624,892	9,490,011	10,110,239	8,496,695	8,628,534	8,892,535	7,389,053	6,977,259
Avg shortage weight/year	1,039,251	1,117,478	1,087,353	1,105,256	1,070,862	949,026	831,571	1,021,007	1,042,078	865,057	914,252
Avg shortage cube/year	44,982	51,912	49,564	50,152	48,126	41,746	38,761	44,690	48,318	41,320	43,391
Avg parts value/demand	162	153	155	160	159	156	156	161	156	157	154
Avg weight/demand	57	55	55	57	57	56	56	57	56	56	55
Avg cube/demand	2.936	2.805	2.844	2.935	2.912	2.851	2.859	2.942	2.856	2.872	2.823
Avg parts value/order	550	491	557	589	541	574	612	646	610	719	663
Avg weight/order	196	175	199	210	193	205	218	231	218	256	233
Avg cube/order	10.073	9.000	10.202	10.792	9.922	10.417	11.221	11.842	11.152	13.169	11.663
Avg time between arrival and demand	-31	-23	-36	-34	-38	-37	-45	-45	-47	-61	-64
Closing inventory (parts)	76,378	77,902	84,643	78,881	65,329	82,449	107,351	101,207	99,379	114,747	126,936
Closing dues-out quantity	60,978	53,466	20,829	20,970	20,177	12,515	23,738	24,657	23,722	17,128	[illegible]
Closing dues-in quantity	116,520	115,086	80,007	82,257	92,341	74,392	58,793	77,147	107,064	91,565	59,167
Pipeline quantity	131,920	139,522	143,821	140,178	136,493	144,906	142,406	153,697	183,311	150,564	172,899
Pipeline value, $	447,855	528,758	743,555	531,275	551,432	572,395	586,627	416,673	756,404	570,417	794,560
MRRS factor = [(1-quantity fill rate) x avg duration of shortage]	.197	.254	.198	.201	.182	.199	.162	.166	.172	.144	.132
Estimated MRRS	.050	.064	.050	.051	.046	.050	.041	.042	.043	.036	.033

Table B6

DETAILED OUTPUT OF SPSM RUNS - DIVISION C
For Alternative Depth Policies
Random Number = 19
6-3 (current Army policy)

Measure	EOQ Operating Level Factors										
	Fixed CL	3.0	4.0	4.4	5.0	5.4	6.3	7.0	8.5	10.0	13.0
Holding cost factor, H	(.40)	.68	.40	.50	.40	.68	.50	.40	.50	.40	.24
Ordering cost, C	(.10)	3.20	3.20	5	5	10	10	10	18	20	20
Avg implied holding and ordering cost/demand	5.40	2.62	2.08	2.85	2.63	4.88	4.38	4.10	6.53	6.75	5.99
Avg implied cost/part demanded	.99	.49	.38	.55	.51	.94	.85	.79	1.28	1.31	1.17
Tech supply fill rate, %	47.8	54.6	60.4	57.7	61.1	62.1	63.7	63.6	63.8	67.8	68.0
Tech supply quantity fill rate, %	45.2	51.3	56.6	55.2	58.6	59.1	61.4	61.6	63.0	65.3	66.9
Avg wait, days	24.7	20.3	22.2	21.5	23.3	23.5	19.5	20.1	21.3	21.0	20.1
Number parts shortages (annual)	296,807	243,282	221,412	226,517	220,570	217,531	199,839	199,945	189,964	179,086	174,998
Part-days of shortage (annual)	13,400,834	10,857,835	11,617,098	11,007,346	11,919,408	12,086,730	9,978,137	10,290,688	10,925,738	10,902,213	10,333,690
Avg duration of shortage, days	45.2	44.6	52.5	48.6	54.0	55.6	49.9	51.5	57.5	60.9	59.1
Percent of days with dues-out	26.4	21.2	21.5	20.4	22.1	22.2	21.8	21.1	23.2	21.3	21.9
Avg inventory (parts)	32,434	58,142	65,264	62,529	69,980	70,316	76,698	79,212	85,995	98,856	110,494
Avg age of inventory, days	48	78	80	81	84	85	88	92	97	106	118
Zero balance, %	33.5	22.7	20.2	22.4	20.6	19.3	18.0	16.7	17.6	15.2	14.2
Percent of zero balance time during which dues-out are recorded (total simulation time)	32.8	27.5	28.1	26.4	28.9	29.2	28.8	27.9	30.6	28.4	29.4
Percent of zero balance time during which dues-out are recorded (time on list)	86.3	87.4	84.8	85.0	87.7	86.9	83.0	87.8	86.5	84.9	86.3
Zero balance with dues-out, %	11.0	6.3	5.7	5.9	5.9	5.6	5.2	4.7	5.4	4.3	4.2
Number demands (annual)	99,809	99,836	98,784	98,233	98,450	99,296	99,406	98,921	100,536	100,750	99,995
Quantity demanded (annual)	543,048	535,534	524,503	512,051	510,907	513,738	512,362	510,842	513,173	520,444	513,530
Avg quantity/demand	5.44	5.36	5.31	5.21	5.19	5.17	5.15	5.16	5.10	5.17	5.14
Number replenishment orders (annual)	45,742	35,300	31,731	30,208	29,327	29,256	28,692	27,571	27,312	26,493	24,982
Total replenishment quantity (annual)	543,183	534,629	525,578	515,179	513,077	512,504	513,476	510,836	511,234	523,194	515,315
Avg quantity/order	11.9	15.2	16.6	17.1	17.5	17.5	17.9	18.5	18.7	19.8	20.7
Quantity received (annual)	540,607	515,864	514,682	506,319	523,047	528,576	516,946	509,348	514,696	525,105	514,509
Avg inventory value, $	234,244	218,933	246,798	257,040	280,752	282,591	297,739	325,288	329,700	374,621	418,126
Avg inventory weight, lbs	105,170	117,799	133,985	139,272	152,042	153,108	161,641	178,026	179,293	209,880	228,753
Avg inventory cube, cu.ft.	5,056	5,553	6,339	6,447	7,192	7,240	7,625	8,391	8,663	10,137	11,021
Avg holding cost/year	81,698	148,874	98,719	128,520	112,301	192,152	148,870	130,115	164,850	149,848	100,350
Avg ordering cost/year	457,420	112,960	101,392	151,040	146,635	292,560	286,920	275,710	491,616	529,860	498,440
Avg shortage cost/year	13,400,834	10,847,740	11,617,098	11,765,736	11,919,408	12,086,730	9,978,137	10,290,688	10,925,738	10,902,213	10,333,691
Avg shortage weight/year	1,295,430	1,269,201	1,115,308	1,035,290	1,079,708	1,144,703	1,198,859	1,207,353	1,197,993	1,078,831	1,080,779
Avg shortage cube/year	59,772	58,732	51,108	46,956	48,260	52,097	54,210	49,564	53,358	48,838	44,661
Avg parts value/demand	163.50	161.19	159.55	156.64	155.94	155.49	154.89	155.18	153.39	155.25	154.32
Avg weight/demand	58	58	57	56	56	55	55	55	55	55	55
Avg cube/demand	2.996	2.954	2.924	2.870	2.858	2.849	2.838	2.844	2.811	2.844	2.888
Avg parts value/order	357	455	498	512	526	526	538	557	562	593	621
Avg weight/order	127	162	178	183	188	188	192	199	201		222
Avg cube/order	6.539	8.340	9.121	9.391	9.633	9.646	9.855	10.202	10.307	10.874	11.306
Avg time between arrival and demand	+2.89	-20.2	-23.3	-23.2	-25.5	-26.2	-34.6	-35.8	-39.8	-48.5	-58.3
Closing inventory (parts)	30,785	54,245	55,198	45,409	82,698	69,698	85,916	84,643	81,363	111,155	113,145
Closing due-out quantity		97,730	85,434	33,361	16,071	16,696	21,114	20,829	21,260	27,704	25,761
Closing due-in quantity	97,524	156,754	170,455	130,978	68,230	92,397	80,377	80,007	76,379	70,886	95,219
Pipeline quantity	99,175	113,269	140,219	143,086	134,557	145,409	145,179	143,821	136,481	154,337	182,603
Pipeline value,	522,735	585,601	724,932	739,755	697,211	731,765	750,575	743,555	705,607	797,982	944,058
NORS factor = [(1-quantity fill rate) x avg duration of shortage]	.248	.217	.228	.218	.224	.227	.193	.198	.213	.211	.196
Estimated NORS	.062	.055	.058	.055	.057	.057	.049	.050	.054	.053	.049

Table 57

SIMSUM OUTPUT, QS POLICY-RELATED MEASURES
DIVISION C

(Random number = 19; Stockage criteria = 6-3; RP = 60 days)

Measure	Run code:	QS policy as indicated, EOQ OL for all other classes						QS classes only						
		RA policy A	[illegible] policy B	C	D	E	F	G	H	J	K	L	M	N
	QS policy	$ 0.5 EOQ ≥ 90	$ 0.5 OL = 300	$ 0.1 OL = 300	$ 0.2 OL = 300	$ 0.3 OL = 300	$ 0.4 OL = 300	$ 0.5 EOQ ≥ 90	$ 0.5 EOQ ≥ 135	$ 0.5 EOQ ≥ 180	$ 0.5 OL = 300	$ 0.1 OL = 300	$ 4.5 OL = 300	$ 4.5 OL = EOQ
Tech supply fill rate, %		64.0	67.7	66.2	68.2	69.8	68.6	68.9	39.7	30.7	76.1	73.5	83.8	64.6
Tech supply quantity fill rate, %		59.5	64.6	63.5	65.2	66.1	65.3	67.0	37.7	25.8	68.7	65.7	81.6	63.5
Avg wait (days)		20.2	20.5	20.8	18.8	19.9	19.8	19.3	40.4	39.8	19.0	21.3	10.7	18.1
Number parts shortages (annual)		201,748	170,758	183,849	173,506	169,122	173,814	119,673	55,636	47,825	120,147	86,075	3,120	6,176
Part days of shortage (annual)		10,602,607	10,387,582	11,054,897	9,981,853	10,583,992	10,513,307	6,929,303	3,746,230	2,843,067	7,906,347	5,993,212	179,233	304,958
Avg duration of shortage, days		52.6	60.8	60.1	57.5	62.6	60.5	57.9	67.3	59.5	65.8	69.6	57.4	49.4
Percent of days with dues-out		22.2	22.6	21.1	21.1	22.0	22.0	26.2	30.3	31.7	19.7	18.6	16.2	21.4
Avg inventory (parts)		82,845	165,855	133,612	149,343	157,107	160,926	69,065	17,138	9,293	152,385	100,298	7,332	2,403
Avg age of inventory, days		98.0	170.6	143.4	154.9	159.6	165.7	104.9	173.0	176.0	190.4	196.7	186.1	82.5
Zero balance, %		21.6	18.3	19.7	18.6	17.8	18.1	22.9	27.0	30.7	12.1	11.6	11.0	22.6
Percent of zero balance time during which dues-out are recorded (total simulation time)		29.5	30.5	28.6	28.6	29.7	29.6	46.3	41.8	39.7	26.5	24.9	23.6	28.7
Percent of zero balance time during which dues-out are recorded (time on list)		80.5	80.8	78.3	76.7	76.4	78.2	80.4	66.1	53.4	81.7	84.6	73.6	79.9
Zero balance with dues-out, %		6.4	5.6	5.6	5.3	5.3	5.4	10.6	11.3	12.2	3.3	2.9	2.6	6.5
Number demands (annual)		100,098	100,367	100,834	100,890	100,656	100,341	57,623	12,685	10,352	67,630	34,576	5,372	5,346
Qty demanded (annual)		525,574	530,589	531,310	531,661	531,113	530,650	358,787	92,806	71,384	415,696	281,274	16,750	16,811
Avg quantity/demand		5.25	5.29	5.27	5.27	5.28	5.29	6.23	7.32	7.36	6.15	8.14	3.12	3.14
Number replenishment orders (annual)		27,567	25,133	26,883	26,385	26,232	25,753	12,531	8,132	7,223	13,410	7,474	748	1,046
Total replenishment quantity (annual)		521.610	535,449	534,016	534,820	535,568	535,550	361,307	92,988	72,202	419,065	284,862	16,761	16,842
Avg quantity/order		18.9	21.1	19.9	20.3	20.4	20.8	28.8	11.4	10.0	31.3	38.1	22.4	16.1
Quantity received (annual)		515,946	515,760	516,650	516,940	519,157	518,693	362,502	91,279	67,956	403,938	266,405	17,299	17,081
Avg inventory value, $		420,521	502,250	431,000	454,343	472,905	480,140	63,086	7,525	4,256	159,481	35,449	32,924	10,814
Avg inventory weight, lbs		227,407	281,141	243,296	260,282	269,733	268,237	44,431	4,272	2,374	112,758	39,813	18,914	6,010
Avg inventory cube, cu. ft.		10,537	13,808	11,375	12,302	12,695	12,867	2,467	255	148	6,306	1,998	1,381	440
Avg holding cost/year		168,208	200,900	172,400	181,737	189,162	192,056	25,234	3,010	1,702	63,792	14,180	13,170	4,326
Avg ordering cost/year		275,670	251,330	268,830	263,850	262,320	257,530	125,310	81,320	72,230	134,100	74,740	7,480	10,460
Holding and ordering cost		443,878	452,230	441,230	445,587	451,482	449,586	150,544	84,330	73,932	197,892	88,920	20,650	14,786
Avg shortage cost/year		10,602,607	10,387,582	11,054,897	9,981,853	10,583,992	10,513,307	6,929,303	3,746,230	2,843,067	7,906,347	5,993,212	179,233	304,958
Avg shortage weight/year		1,040,629	1,098,538	1,087,612	1,008,056	1,020,849	1,106,853	70,469	19,348	17,667	111,822	72,615	7,314	15,629
Avg shortage cube/year		47,879	50,127	49,958	46,347	47,249	50,769	3,629	1,072	973	4,220	2,474	404	1,046
Avg parts value/demand		158	159	158	158	159	159	7	7	7	7	3	14	14
Avg weight/demand		56.3	56.7	56.5	56.4	56.6	56.7	3.9	3.5	3.3	4.4	4.0	6.3	6.4
Avg cube/demand		2.891	2.912	2.901	2.902	2.905	2.912	.216	.209	.194	.325	.361	.410	.413
Avg parts value/order		567	635	597	609	614	625	35	12	10	38	13	101	73
Avg weight/order		202.3	226.5	212.9	217.3	218.8	222.9	18.0	5.5	4.8	22.4	18.6	45.6	32.7
Avg cube/order		10.419	11.635	10.938	11.161	11.242	11.451	1.001	.327	.281	1.653	1.689	2.945	2.115
Closing inventory (parts)		95,140	143,536	103,166	123,579	135,002	139,213	80,506	20,068	13,893	131,826	69,697	8,320	3,997
Closing dues-out quantity		60,655	74,503	71,652	80,223	74,412	74,481	28,668	19,663	28,476	68,124	64,797	516	494
Closing dues-in quantity		114,153	176,012	172,429	177,940	170,354	173,013	81,338	24,204	29,364	148,675	136,691	4,851	1,852
Pipeline quantity		148,638	245,045	203,943	221,295	230,354	237,745	133,176	24,609	14,781	212,377	141,591	12,655	5,355
Pipeline value, $		755,081	841,996	658,736	672,740	694,961	708,480	121,643	10,828	6,799	222,253	50,038	56,826	24,099
Avg AML size		4,317	4,323	4,455	4,398	4,386	4,360	2,878	1,134	800	2,867	1,635	187	178
Number of FSNs on QS list		2,894	2,930	1,686	2,188	2,496	2,735	2,834	1,163	828	2,930	1,686	195	195
Avg implied holding and ordering cost/demand		4.43	4.51	4.38	4.42	4.49	4.48	2.61	6.65	7.14	2.93	2.57	3.84	2.77
Avg implied cost/part demanded		.84	.85	.83	.84	.85	.85	.42	.91	.80	.48	.32	1.23	.88

TABLE 88

QS LIST

DIVISION C

FSN	UNIT PRICE	NOUN
4730-010-3875	.12	PLUGPIPE
5310-010-5604	.37	NUTPLAIN
5920-010-6652	.04	FUSECART
5305-011-1687	.46	SCREW
5310-011-5093	.31	WASHER
5310-011-6121	1.36	WASHER
5310-011-6124	1.45	WASHER
5315-011-9120	.24	PINCOTTR
5315-012-0123	.33	PINCOTTR
5310-012-0239	.40	WASHER
5310-012-0399	.58	NUT
5310-012-2901	.14	NUT
5315-013-7214	.40	PINCOTTR
5306-019-0515	.02	BOLTASSY
4730-019-0797	1.06	NIPPLE
6240-019-0877	.15	LAMP
5306-019-1676	.03	BOLTASSY
6240-019-3093	.22	LAMP
6240-019-3102	.32	SCREW
5305-021-3740	.06	SCREW
6240-025-8992	.83	LAMP
4820-026-8473	.52	COCKDRAI
2590-040-2075	.62	FASTENER
5306-042-4208	.02	BOLTASSY
5306-042-5325	.99	BOLTASSY
5306-042-5594	.02	BOLTASSY
5305-042-6417	.05	SCREWCAP
5310-042-7475	1.11	NUTSLCT
5305-044-1201	.01	SCREWCAP
2640-050-1229	.05	VALVE
5306-050-1924	2.64	BOLTMACH
5920-050-4965	.10	FUSE
2640-052-0828	.13	PATCH
5310-053-7804	.20	NUT
5310-053-7808	.22	NUT
5315-054-4190	2.20	PIN
5340-055-1100	1.96	PINQUICK
5320-058-9890	2.44	RIVET

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TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
2640-060-3550	.03	CAPTIRE
5310-062-4954	5.48	NUTSELF
5306-065-1972	.57	BOLTEYE
5305-068-0500	.68	SCREWCAP
5305-068-0502	.72	SCREWCAP
5305-068-0505	.87	SCREWCAP
5305-068-0506	.62	SCREWCAP
5305-068-0507	.82	SCREWCAP
5305-068-7837	.02	SCREWCAP
5305-071-2081	.15	SCREWCAP
5305-071-2241	.01	SCREWCAP
5340-077-8727	.85	CLIPSPRN
5310-080-6004	.21	WASHER
5305-082-6756	.15	SCREW
2590-086-6627	.40	PINPIVOT
5310-087-4652	.03	NUTSELF
5315-088-1875	1.81	PINHEX
2590-113-0749	.66	BUTTHORN
4010-129-3221	2.19	CHAIN
2920-133-9629	2.50	SWITCH
6240-143-3060	.15	LAMP
5935-149-3534	.46	ADAPTER
6240-155-7836	.26	LAMP
6240-155-7967	.10	LAMP
6240-155-8683	.08	LAMP
6240-155-8736	.05	LAMP
4820-174-0330	.93	COCKPLUG
4820-174-0340	.13	COCKDRAI
5935-192-4753	.71	PLUG
5310-194-9209	.28	WASHER
5310-194-9213	.88	WASHER
4730-196-1482	.08	NIPPLE
6240-196-4501	.08	LAMP
5325-202-2053	3.68	GROMMET
5330-202-3749	.02	WASHER
5305-206-0932	.26	SCREW
5305-206-4732	.98	SCREW
5306-206-6340	.24	BOLTRIB
5305-207-0728	.04	SETSCREW
5310-208-1318	1.22	NUTSELF
5310-209-1761	.09	WASHER
5315-209-7979	.09	PIN
5305-225-3839	.84	SCREWCAP
5310-225-6993	.04	NUTSELF
5305-225-8497	.01	BOLTMACH
5306-225-8502	.02	BOLTMACH

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5306-226-4822	.03	BOLTMACH
5306-226-4823	.03	BOLTMACH
5306-227-0930	.22	BOLTMACH
5315-241-2924	.02	FIN
5330-253-2469	.13	WASHER
2640-255-9349	.08	PATCH
6240-266-9940	.14	LAMP
5305-267-8976	.02	SCREWCAP
5305-269-2803	.03	SCREWCAP
5305-269-2806	.02	SCREW
5305-269-2808	.03	SCREW
5305-269-3210	1.70	SCREW
5305-269-3211	1.98	SCREW
5305-269-3213	2.04	SCREWCAP
5305-269-3217	.04	SCREWCAP
5305-269-3219	.04	SCREWCAP
5305-269-3235	.03	SCREW
5305-269-3236	.03	SCREW
5305-269-3238	.04	SCREW
5305-269-3241	.04	SCREWCAP
5310-269-7044	.19	NUT
4030-270-5436	.31	HOOK
5310-271-8832	.12	WASHER
4820-272-3360	1.02	COCKPLUG
2640-272-6410	.56	REPAIRKI
5310-274-9364	7.00	NUTSELF
5325-276-6089	.03	GROMMET
5325-276-6091	2.75	GROMMET
4730-278-2064	.07	CLAMP
4730-278-4496	.44	ELBOW
5920-280-5039	.13	FUSE
5920-280-8342	.04	FUSE
5920-280-8344	.05	FUSE
5920-280-9328	.12	FUSE
5315-281-7744	.08	PIN
5315-281-7745	.15	PIN
5340-283-0649	.03	CLAMP
5940-283-5393	.04	CAP
5355-284-5517	.66	KNOB
5355-284-5671	.39	KNOB
5920-284-6796	.15	FUSE
5325-285-6255	.19	STUCTURN
5310-285-7037	.01	WASHER
4730-287-1706	.18	ELBOW
4820-287-4268	.59	COCKDRAI
4820-287-4648	1.39	COCKPLUG

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
4730-289-5942	.50	PLUG
5315-290-6132	.65	PIN
2990-291-7475	.19	GASKET
5305-297-3273	.76	SCREW
5310-297-3314	.01	WASHER
5315-298-0995	.30	PIN
5310-298-9261	.20	NUT
5360-301-5866	.28	SPRING
2805-308-8377	.89	GASKET
5306-312-0845	1.45	BOLTMACH
5315-316-0992	.18	PIN
5340-321-6183	1.82	HOOK
5340-321-6405	.14	FASTENER
5340-321-6406	.04	FASTENER
5310-323-3838	.08	WASHER
1005-333-3577	.33	GRIP
5310-333-7519	.03	WASHER
5305-335-4665	.32	THUMBSCR
5340-342-5577	.10	CAPPROTE
5355-350-2457	.39	KNOB
5315-350-4326	.11	PIN
4820-350-6495	2.05	COCKPLUG
5310-350-7499	.37	NUTPLAIN
5355-379-2522	.24	KNOB
5355-379-2523	.24	KNOB
5355-379-2524	.28	KNOB
5310-379-2531	.18	NUT
5310-407-9566	.21	WASHER
5340-423-2808	.10	BUSHING
4730-439-8129	.15	CLAMP
5330-467-3615	.16	PAPER
5305-494-0326	.02	SCREW
5310-497-3892	.05	NUT
6240-500-1762	.79	LAMP
5315-500-9273	.14	PIN
1005-500-9351	.10	SPRING
5305-500-9394	.21	SCREW
5305-501-3160	.43	SETSCREW
5315-501-3199	.02	PIN
5315-501-3203	.04	PIN
5315-501-3206	.10	PIN
5315-501-3207	.04	PIN
5315-501-3209	.03	PIN
5315-501-3210	.07	PIN
5315-501-3211	.06	PIN
5315-501-3424	.27	PIN

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5320-501-3522	.20	RIVET
5315-501-3529	.11	PIN
1005-501-3541	3.75	STRIPPER
5310-501-3545	.20	WASHER
5315-501-3546	.13	PIN
5310-501-3556	.59	NUT
5315-501-3668	.04	PIN
5306-501-3681	2.95	BOLT
5310-501-3686	.62	NUT
5315-501-3694	.33	PIN
5305-502-2249	.08	SCREW
5935-511-6534	.65	CONNECTI
5306-513-5871	.69	BOLT
5310-513-9964	.08	NUT
5306-513-9973	.59	BOLT
5305-513-9989	.06	SCREW
5310-514-0212	.10	NUT
5315-514-0217	.14	PIN
5330-514-3289	1.20	GASKET
5310-514-6158	.82	NUT
5315-515-2839	.12	PIN
5315-515-2854	.17	PIN
5310-515-2939	.52	NUT
5306-516-9882	.24	BOLT
5310-523-6961	.02	WASHER
5305-527-5751	.01	SCREW
5360-527-7767	.56	SPRING
2520-529-1733	.05	PLATE
5305-531-0451	.01	SCREW
5305-531-0452	.76	SCREW
5310-532-9467	1.70	WASHER
5305-534-4952	.36	SCREW
5315-534-9935	.20	PIN
5315-534-9938	.05	PIN
5315-534-9944	.12	PIN
5315-534-9948	.06	PIN
5315-535-1190	.12	PIN
5306-538-0854	3.51	BOLT
5306-538-0856	1.15	BOLT
5340-541-4376	.50	CLAMP
5310-543-2009	.36	WASHER
5340-543-3138	.43	STRAP
5305-543-4372	.03	SCREW
5340-543-4394	.02	CLAMP
5306-543-5218	.04	BOLT
5306-543-5898	.30	BOLTHCCK

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5940-549-6581	3.04	TERMINAL
5940-549-6583	1.72	TERMINAL
5310-550-1130	.10	WASHER
5305-551-5890	.0[illegible]	SCREW
5355-556-0145	.37	KNOB
5920-557-2647	.04	FUSE
5305-561-0346	.10	SCREW
5305-569-8941	.07	SCREW
5305-576-5417	.05	SCREW
5355-579-1210	.42	KNOB
5330-579-7911	.06	PACKING
2940-580-5283	1.30	FILTER
5920-581-4144	.15	FUSE
5310-582-5965	.14	WASHER
5310-584-5272	.01	WASHER
5310-594-0338	.32	NUT
5310-595-7157	.01	WASHER
5310-595-9659	.13	NUT
5315-597-7399	.01	PINCOTTR
5340-598-4195	.04	CLAMP
5340-598-4201	.03	CLAMP
5340-598-8062	.03	CLAMP
5305-601-9023	.05	SCREW
5315-608-5024	.10	PIN
1005-608-5172	1.66	GUIDE
5315-608-5173	.33	PIN
5305-616-1513	.10	SCREWCAP
5340-619-1353	1.06	CLAMP
5310-627-6126	.32	WASHER
5310-637-9541	.30	WASHER
5306-637-9674	.04	BOLTMACH
5305-638-0957	1.10	SCREWTHU
5305-638-1786	.03	SETSCREW
5306-638-3181	.33	BOLT
5306-638-8209	.24	BOLT
5305-638-8869	.06	SCREWCAP
5305-638-8920	.05	SCREWCAP
5305-639-1679	.08	PLATE
4820-639-9224	2.67	PLUGCOCK
5355-644-2114	.28	KNOB
5355-644-2163	.27	KNOB
5310-655-9276	.13	NUT
5305-655-9382	.08	SCREW
5310-655-9542	.04	WASHER
5310-655-9668	.02	WASHER
5310-655-9669	.02	WASHER

TABLE 88 (CONT)

FSN	UNIT PRICE	NOUN
5310-655-9860	.52	NUT
5310-655-9863	.10	NUT
5305-656-0021	.08	SETSCREW
5355-656-1358	.35	KNOB
5310-660-3381	1.95	NUTSELF
5305-667-9518	.11	THUMBSCR
5325-676-5064	.01	STUD
2805-678-1386	.31	CAPFILL
5306-678-4262	.77	BOLT
5306-678-4787	.35	BOLT
5305-678-6195	.87	SETSCREW
5310-679-4993	1.76	WASHER
5310-679-5017	.54	NUT
5310-679-9810	.55	NUT
5340-679-9878	3.37	HINGE
5320-682-1862	.01	RIVET
5315-682-2025	.10	PIN
5315-682-2073	.18	PIN
5305-682-5592	.05	SETSCREW
4820-684-0880	.24	COCKDRAI
5305-690-0552	.17	SETSCREW
1305-690-0562	.03	SPRING
5306-695-7173	.22	BOLT
5306-696-5294	.01	SCREW
5306-699-6301	.18	SCREW
5307-699-6390	.11	SHOULDER
5315-699-7781	.19	PIN
5315-699-8465	.88	PIN
5355-700-5418	.43	KNOB
6145-705-6678	.05	CABLE
5940-705-6714	.65	TERMINAL
5315-706-9195	1.29	PIN
5340-707-1099	.37	CLAMP
5340-707-1100	.40	CLAMP
5355-708-8745	.33	KNOB
5305-710-4193	.05	SETSCREW
5305-719-5219	.06	SCREWCAP
5305-719-5235	.06	SCREWCAP
5305-719-5342	.01	SETSCREW
5305-725-4145	4.49	SETSCREW
5305-725-4187	.05	SCREW
4710-726-5459	.65	TUBING
5305-726-6548	.02	SCREW
5305-728-6311	.02	SETSCREW
5305-730-7478	.26	SETSCREW
5315-731-2517	.08	PINLOCK

RAC

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
1605-731-2723	1.75	SHAFT
5315-731-2970	06	FINLOCK
5310-732-0558	.59	NUT
5355-732-0656	.40	KNOB
5306-732-8293	4.53	BOLT
5340-734-6976	.41	CLAMP
5310-734-8837	.03	WASHER
5340-736-8636	.32	CLAMP
5315-736-8685	.11	PIN
5310-737-1106	.27	NUT
2510-737-2788	.09	CLAMP
6140-737-3211	.21	CLAMP
5315-737-3224	.26	PIN
4730-737-3252	.50	CONNECTR
5306-737-3263	.28	BOLT
5306-737-6150	.03	BOLT
5307-737-6343	.14	STUD
5365-737-6357	.44	PLUG
5306-739-7754	.49	BOLT
5315-740-9378	.19	PIN
5315-740-9379	.21	PIN
5360-740-9447	.30	SPRING
5306-740-9555	.42	BOLT
5306-741-1180	.50	BOLT
5306-741-1183	.82	BOLT
5315-741-2515	.08	PIN
5306-741-4584	1.50	BOLT
5315-741-8971	.07	PIN
5306-752-1001	3.68	BOLT
5306-752-1155	.74	BOLT
5306-752-1158	.05	BOLT
5310-752-1166	1.32	NUT
5340-752-1235	.08	RING
5306-752-1631	.09	BOLT
5310-752-1633	1.64	NUT
5315-752-1651	.10	PIN
5340-752-1755	.50	CLAMP
5340-752-1756	1.42	CLAMP
4720-752-1973	.86	HOSEPRE
5340-753-9226	.10	BUMPER
5315-753-9311	.27	PIN
5315-753-9663	.31	PIN
5340-753-9736	.23	RING
5310-759-5768	.03	WASHER
5305-761-4227	.05	SCREWCAP
5310-761-6882	.35	NUT

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5310-768-0319	.35	NUT
5340-768-8571	1.10	PIN
5340-768-8575	1.15	PIN
5315-769-9609	1.76	PIN
5340-770-5862	3.07	PINASSY
6145-772-0853	.03	CABLE
5315-772-7681	2.84	KEY
5340-776-1546	.12	SPRING
5310-792-3588	.17	NUT
5306-797-9320	.36	BOLT
5305-796-5102	.15	SETSCREW
5340-799-7721	.20	BUSHING
5306-799-7722	.16	BOLT
4720-805-0527	3.82	HOSE
4710-805-4149	.04	TUBING
5315-805-6875	.13	PIN
5310-809-4058	.19	WASHER
5310-809-4061	.43	WASHER
5315-809-5417	.25	PIN
5310-809-5998	.52	WASHER
5310-809-8533	.01	WASHER
5310-809-8541	.04	WASHER
5315-810-3701	.40	PIN
5315-814-5227	.15	PIN
5310-815-1073	.16	NUT
5315-815-1405	.21	PIN
5315-815-4773	.15	PIN
5315-815-8840	.04	PIN
5315-816-1794	.18	PIN
5940-816-6058	1.00	TERMINAL
6145-823-3055	.14	CABLE
5305-823-5837	.08	SCREW
5305-823-5838	.02	SCREW
5315-823-8764	.35	PIN
5310-823-8803	2.00	WASHER
5355-823-9809	.67	KNOB
5310-828-8189	.04	NUT
5306-829-2220	.16	BOLT
5306-829-2221	.17	BOLT
6685-832-5740	5.14	GAGE
5365-832-7903	.27	PLUG
5310-833-8567	.02	WASHER
5305-837-5949	.12	SCREWCAP
5310-839-2323	2.16	NUT
5315-839-5820	.13	PINCOTTR
5315-839-5821	.24	PINCOTTR

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TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5315-839-5822	.24	PINCOTTR
2540-840-9555	1.05	CLAMP
5315-842-3044	.14	PINCOTTR
5315-842-3651	.45	PINCOTTR
5306-843-1723	.49	BOLT
5330-844-2447	.21	PACKING
5305-844-6400	2.50	SCREW
5315-845-4232	.03	PIN
5307-845-5729	2.20	STUDBALL
5315-846-1270	.07	PIN
5305-847-0784	.05	SCREW
4820-849-1220	.09	COCKDRAI
5305-849-1362	.10	SCREW
5306-851-0179	.76	RESISTCR
5306-851-0180	.36	BOLT
5355-853-6353	.57	KNOB
5355-853-6384	.29	KNOB
5310-853-9676	.06	NUT
5310-854-6481	.47	NUT
5330-854-6929	.10	WASHER
4720-865-8324	.37	TUBING
5310-865-9513	.03	WASHER
5310-866-4417	.06	WASHER
5310-866-4418	.09	WASHER
5340-876-8566	1.59	PIN
5310-877-5796	.02	NUT
5310-877-5797	.02	NUT
5310-877-5972	.03	WASHER
5310-877-5973	.03	WASHER
5310-883-7746	.41	NUT
2540-884-1205	1.56	MIRROR
5310-889-2528	.48	WASHER
5310-889-2606	.04	NUT
5305-889-3023	.17	SCREW
5355-889-3424	.48	KNOB
5355-889-3425	.48	KNOB
5305-893-8484	.05	DIALCCNT
5310-896-0789	.03	NUT
5306-900-0400	1.22	BOLT
5330-901-4407	.08	PACKING
5330-905-6032	.04	PACKING
5325-907-0704	.12	STUD
4730-908-3193	.13	CLAMP
4730-908-3195	.19	CLAMP
4730-909-8627	.15	CLAMP
5306-920-0640	.67	BOLT

TABLE B8 (CONT)

FSN	UNIT PRICE	NOUN
5305-922-7994	.22	SCREW
5305-922-7995	.47	SCREWCAP
5310-930-8214	.03	NUT
5310-930-9224	.07	WASHER
2510-932-3536	1.65	BOLT
5306-933-1128	.58	BOLT
5315-935-9084	.13	PIN
5305-939-9204	.15	SCREW
5310-950-0039	3.02	NUT
5310-957-5071	.32	NUT
5310-959-7600	.02	NUT
5355-962-3018	.31	KNOB
5310-964-3414	.02	WASHER
5310-974-9845	.60	NUT
5310-982-6809	.09	NUT
5310-982-6810	.15	NUT
5305-983-6651	.03	SCREWCAP
5305-983-6658	.02	SCREW
5305-983-6064	.04	SCREWCAP
5310-984-3806	.01	NUT
5305-984-5680	1.42	SCREW
5305-988-1723	.63	SCREW
5310-989-6008	.37	WASHER
5305-989-7435	.31	SCREW

Table B9

FSNs CAUSING MORE THAN 10 EQUIPMENT-WEEKS OF DEADLINE

FSN of deadlining part	Noun	AMDF unit price	AMDF recoverability code*	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
2530-337-6969	Shoe assy	29.59	-	802	8	4
2530-087-1515	Gear assy	26.21	-	125	14	6
6140-057-2554	Battery	21.73	U	119	58	7
2920-909-2483	Generator	167.00	R	116	38	10
1005-992-6655	Spring	.02	-	92	48	3
2920-900-7993		40.59	R	88	35	7
5306-150-3146	Bolt	.32	-	77	3	1
6140-057-2553	Battery	13.37	U	76	54	18
2590-050-8821	Installation kit	32.32	-	75	25	3
2920-782-1955	Generator	213.00	D	74	21	7
1005-763-1863	Bolt assy	28.41	R	68	4	1
2530-733-8155	Track shoe	27.74	-	66	5	4
1025-089-4788	Box assy	555.00	S	65	17	4
5306-071-4473	Bolt	.15	-	64	1	1
2520-176-3331	Parts kit	3.06	-	63	36	10
1025-853-7572	Box assy	877.00	S	62	19	5
2520-832-5653	Parts kit	2.40	-	59	35	18
2520-678-1282	Propeller	25.10	-	58	22	14
2930-862-6939	Radiator	92.28	R	54	14	8
2910-737-4912	Tank	47.96	R	53	13	10
2530-911-7651	Hub assy	189.00	-	52	13	2
5310-866-4417	Washer, flat	.06	-	52	4	1
1025-908-8271	Relay assy	23.59	T	51	7	2
2520-678-3072	Shaft assy	8.92	-	51	28	18
4310-115-0634	Compressor	1582.00	-	50	17	5
2590-033-7762	Wire rope	1.76	-	47	12	4
1025-179-1316	Power supply	734.00	S	46	14	2
2530-887-1341	Parts kit	3.22	-	46	27	11
2920-828-4147	Starter	114.00	-	45	19	4
2805-678-1367	Gasket	.56	-	45	22	15
2520-690-1600	Coupler	16.73	-	43	6	3
2805-771-9112	Cylinder	71.28	-	43	20	13
4310-460-2184	Compressor	1582.00	-	42	11	2
6685-814-4772	Indicator	4.18	-	41	8	3
2530-133-8130	Cylinder	38.14	-	40	4	2
2520-714-6157	Spider, U-joint	8.76	-	40	7	4
2910-918-0609	Fuel pump	14.98	-	40	7	5
6145-308-0080		-[a]		39	5	1
3110-084-0266	Retainer	28.43	-	39	9	2
3110-463-5563	Bearing	7.80	-	38	9	2
1005-056-2251	Guard	1.20	-	38	10	1
2805-134-1182	Tube, dip	2.72	-	38	6	2
1005-017-9543	Swivel	.19	-	37	37	1
1240-762-9334	Mount, telescope	772.00	R	36	13	4

*See Recoverability code list at end of Table B-9.

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recoverability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
5820-892-0622	Receiver	1329.73	-	35	8	2
1005-017-4543		-[a]		35	35	1
4720-840-0011	Hose, rubber	.43	-	35	5	1
5820-856-2728	Antenna	6.76	-	35	16	1
2930-064-5979	Radiator	39.39	-	35	18	12
6685-814-5271	Transmitter	1.41	-	35	15	11
5945-612-5740	Relay	18.68	-	35	22	7
2805-678-1391	Manifold	11.79	-	34	18	10
1005-608-5184	Spring	.05	-	34	5	2
5930-538-1051		-[a]		34	4	1
2530-353-2436	Lock,bearing	.11	-	32	6	4
1025-134-3052	Power supply	156.00	-	32	16	2
6810-249-9354	Sulfuric acid	.78	-	31	16	5
2910-678-1856	Fuel pump	31.88	-	30	19	13
2510-437-1009	Door hatch	501.00	-	30	3	1
2930-930-3108	Seal, plain	2.17	-	29	9	2
2530-737-3717	Shaft, axle	13.22	-	29	22	16
2910-096-6169	Carburetor	33.60	-	29	17	8
2990-678-3240	Pipe, exhaust	2.44	-	29	16	8
2520-734-8844	Shaft assy	39.14	R	29	5	5
6130-065-1975	Rectifier	80.28	R	28	9	2
5820-893-1323	Base	40.00	A	28	3	2
2530-272-8106	Link, wheel	.40	-	28	1	1
5310-523-6961	Washer	.02	-	28	1	1
5315-740-9379	Pin, grooved	.18	-	28	1	1
1025-930-8595	Cylinder	415.00	-	28	3	1
2910-017-8925	Fuel pump	6.10	-	27	13	8
2920-678-1858	Drive, engine	6.96	-	27	9	7
5930-771-8119	Switch	4.35	-	27	12	7
1005-017-9547	Pin, firing	.81	-	27	12	2
1025-087-1530	Fan, van	244.00	-	27	4	2
3030-130-5209	Belts, V	1.78	-	27	4	2
2530-784-9292	Wheel, solid	83.23	T	27	2	1
2520-678-3079	Shim	.19	-	26	15	11
2920-953-9784	Regulator	35.79	R	26	20	11
2530-693-0625	Seal, plain	.99	-	26	9	5
2920-065-7536	Distributor	24.66	-	26	14	4
2930-045-2672	Radiator	90.27	R	26	4	3
2510-917-0882	Shackle	6.07	-	26	2	2
2590-593-1790	Pump, hyd	119.00	-	26	3	1
6620-938-8212		3.68	-	25	14	12
2520-678-3115	Parts kit	5.58	-	25	17	10

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recover-ability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
2805-353-7911	Gasket	2.42	-	25	10	8
2590-033-7760	Wire rope	1.63	-	25	11	6
2520-040-2318	Pump	131.00	R	25	7	2
1005-912-1146	Spring	.08	-	24	5	4
4210-910-9663	Cylinder	30.50	-	24	10	3
1025-916-9062	Servomotor	345.00	S	24	8	3
6685-484-3472	Gage, pressure	25.69	-	24	8	2
2805-740-9968	Head assy	232.00	-	24	5	2
1005-992-7292	Spring	.04	-	24	5	2
5305-269-3243	Screw	.04	-	24	2	1
2530-903-0593	Wheel, solid	34.00	-	24	5	1
2530-955-9448	Track shoe	102.00	-	24	1	1
2920-231-0214	Starter	80.00	-	23	8	4
2510-508-2273	Footrest	35.68	-	23	4	4
2530-941-8683	Coupling	6.27	-	23	8	4
3110-195-0454	Bearing	13.20	-	23	5	2
1025-410-2340	Control	567.00	S	23	3	2
2530-941-8685	Pump, hyd	43.41	-	23	8	2
2910-966-5957	Hose assy	1.49	-	23	6	2
4730-702-2847	Elbow, pipe	1.48	-	23	5	1
5820-892-0871	Radio set	1427.00	-	23	11	1
5330-941-3582	Packing	.68	-	23	6	1
2920-636-8779	Relay	23.30	-	22	17	11
2530-737-3716	Shaft, axle	16.89	-	22	13	8
2990-678-3231	Parts kit	15.13	-	22	14	7
2920-927-3279	Distributor	31.34	R	22	9	5
2930-276-5656	Pin, straight	.17	-	22	4	3
2805-740-9971	Head assy	172.44	R	22	8	3
2805-937-0942	Parts kit	2.71	-	22	7	3
1025-113-9665		-[a]		22	9	2
2910-865-6312	Air cleaner	13.40	-	22	2	2
4720-289-4481	Hose assy	2.20	-	22	3	1
5315-761-1680	Key, machine	.10	-	22	1	1
2805-843-9377	Valve, check	.60	-	22	1	1
5315-845-4232	Pin, straight	.03	-	22	4	1
5310-954-1241	Nut, plain	.50	-	22	13	1
3110-992-1068		-[a]		22	4	1
2930-737-3692	Radiator	57.71	R	21	11	8
2920-314-0556	Generator	148.00	P	21	11	5
2920-818-8635	Generator	134.41	D	21	7	5
2530-999-8860	Seal	.40	-	21	5	5
6685-335-9508	Indicator	4.11	-	21	7	4
4730-595-0083	Coupling	1.23	-	21	4	3

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recover-ability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
5340-888-9390	Coupling	3.11	-	21	8	3
2530-[illegible]-3580	Stud, wheel	.25	-	21	4	3
2530-318-1016	Hose assy	5.72	-	21	4	2
2590-800-2841	Bracket	7.70	-	21	2	2
2590-867-8797	Cable assy	1.83	-	21	2	2
1025-908-4113	Amplifier	339.00	S	21	10	2
6210-542-6393	Light, ind	.95	-	21	6	1
2520-679-8945		-[a]		21	1	1
4820-706-5931	Plug, cock	1.67	-	21	2	1
2590-782-4189	Connector	11.15	-	21	2	1
2930-632-4048	Pump, engine	8.13	-	20	15	10
4730-277-8274	Elbow, pipe	.24	-	20	7	4
2520-914-1751	Bearing	5.22	-	20	7	4
1005-056-2252	Guard	.90	-	20	10	1
1025-824-0516	Spring	.16	-	20	2	1
2990-066-8874	Pipe, exhaust	16.67	-	19	11	7
1010-704-6621	Pin, firing	.47	-	19	8	4
3110-198-1468	Cone and roller	5.12	-	19	5	3
1515-918-2677	Gear box	1538.00	D	19	11	3
1025-126-2470	Switch, light	5.00	R	19	2	2
3110-227-2559	Bearing	4.50	-	19	2	2
2530-722-3637	Arm, wheel	355.00	-	19	3	2
5340-999-4291	Ring, ret	.63	-	19	8	2
2540-801-5692	Bearing	12.54	-	19	1	1
5340-867-8788	Spring	.08	-	19	2	1
2910-883-22[illegible]	Hose assy	6.28	-	19	1	1
3110-933-7364	Bearing	6.05	-	19	7	1
2530-678-3076	Socket assy	5.05	-	18	7	7
2990-992-9278	Pipe, exhaust	16.02	-	18	5	4
1005-608-5271	Spring	.89	-	18	9	3
2520-806-1107	Cover plate	4.56	-	18	4	2
3110-723-0807	Roller bearing	.47	-	18	1	1
2530-740-9448	Stem, ped	4.28	-	18	1	1
5315-815-8840	Pin, straight	.04	-	18	3	1
2530-706-1320	Tube assy	1.51	-	17	7	7
2540-698-6703	Control	1.51	-	17	7	5
2530-693-0679	Brake shoe	4.91	-	17	6	4
2990-734-8834	Pipe, exhaust	23.64	-	17	5	4
2530-678-3077	Cylinder	7.74	-	17	5	3
2920-781-4300	Magneto	40.10	-	17	6	2
2520-808-2401	Shaft assy	9.98	-	17	2	2
2590-884-4860	Cylinder	116.00	-	17	2	2
2540-740-9423	Mirror assy	3.05	-	17	2	1

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recover- ability code	Equipment- weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
1240-762-9333	Telescope	1837.00	R	17	6	1
3120-809-6646	Bearing	.50	-	17	1	1
4720-845-4365	Hose, rubber	2.22	-	17	1	1
4730-908-3194	Clamp, hose	.17	-	17	3	1
1430-921-6443		-[a]		17	7	1
4210-930-2625	Extinguisher	43.00	-	17	5	1
3110-930-7364	Spacer	4.93	-	17	3	1
2510-933-4434	U-bolt	2.06	-	17	1	1
2910-966-9135	Carburetor	9.78	-	17	4	1
2910-921-5618	Repair kit	23.72	-	16	13	7
3110-100-0684	Cone and roller	7.80	-	16	6	4
5930-699-9438	Switch	3.40	-	16	5	4
2920-810-7082	Spark plug	.51	-	16	6	3
2520-872-5991	Seal, plain	.81	-	16	2	2
5305-071-2072	Screw	.07	-	16	1	1
4730-080-7043	Adapter	.94	-	16	3	1
2920-475-1446	Generator	485.00	R	16	1	1
2530-703-5899	Torsion bar	59.84	-	16	1	1
5310-740-9385	Washer	.07	-	16	1	1
1025-861-1475	Spring	.07	-	16	1	1
2805-678-1379	Gasket	.07	-	15	7	7
2920-678-1850	Starter	37.26	R	15	6	5
2530-732-1379	Seal, plain	14.97	-	15	8	5
2530-911-3601	Spindle	61.04	-	15	5	4
2590-076-1935	Lead assy	15.15	-	15	7	3
4730-235-1777	Tubing, rubber	.09	-	15	6	3
3030-253-8335	Belt, V	1.09	-	15	4	3
2590-033-7763	Wire rope	1.23	-	15	4	2
2815-678-4247	Tube assy	17.80	-	15	2	2
1025-844-5434	Box assy	72.92	-	15	4	2
5305-071-2075	Screw	.15	-	15	1	1
2805-110-9778	Gasket	.48	-	15	1	1
2930-507-1973	Pump assy	36.00	-	15	2	1
1005-608-7289		-[a]		15	3	1
2920-675-0548	Cable assy	2.60	-	15	1	1
2930-711-8354	Fan, vane	403.00	R	15	3	1
2590-782-1190	Pivot	4.68	-	15	1	1
6625-961-6178	Meter	10.12	-	15	2	1
3110-992-1072	Bearing	6.05	-	15	4	1
2910-878-8839	Carburetor	14.16	-	14	12	7
2530-560-3618	Spindle	22.66	-	14	8	4
2990-886-8085	Parts kit	3.27	-	14	7	4
5330-291-7451	Insulation	3.22	-	14	5	3
2520-914-1752	Cover plate	3.24	-	14	3	3

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recover-ability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
5305-269-3241	Screw, cap	.05	-	14	4	2
6620-695-6238	Transmitter	10.16	Z	14	6	2
1240-788-5463	Periscope	5193.00	-	14	7	2
4720-235-4134	Hose, rubber	.24	-	14	3	1
2910-293-7179		-[a]		14	1	1
2530-359-1146	Hub	27.70	-	14	1	1
4730-620-0932	Coupling	1.00	-	14	2	1
4820-714-6137	Deflector	.57	-	14	2	1
1240-864-2930	Telescope	1922.00	R	14	1	1
2520-916-4837	Bolt, wheel	.95	-	14	1	1
2530-933-3726	Brake drum	23.10	-	14	1	1
2960-999-6216	Starter	94.83	R	14	1	1
6130-314-0545	Rectifier	26.00	-	13	9	9
3030-849-1033	Belt, V	.72	-	13	10	8
2930-142-0144	Fan, engine	3.00	-	13	7	6
2530-887-1348	Parts kit	1.18	-	13	8	6
2805-741-0947	Gasket	.45	-	13	7	5
4720-763-7729	Hose, rubber	.40	-	13	5	5
3030-676-8945	Belts, V	1.64	-	13	5	4
3110-198-0014	Cup and tape	1.50	-	13	4	3
2910-570-3045	Carburetor	15.80	-	13	4	3
2530-678-3116	Parts kit	2.35	-	13	4	3
2930-762-1391	Pulley, grooved	18.49	-	13	6	3
4730-908-3193	Clamp, hose	.15	-	13	3	3
2930-950-0740	Cap, radiator	.9[illegible]	-	13	3	3
2510-037-2605		-[a]		13	2	2
5365-142-6925	Spacer	10.04	-	13	4	2
2910-705-7882	Fuel tank	34.08	-	13	4	2
2920-786-9250	Pulley, grooved	16.71	-	13	3	2
2520-886-9555	Support	69.60	-	13	4	2
5930-945-4450	Switch	35.30	-	13	4	2
2590-169-5793	Stud	.15	-	13	1	1
5930-307-8856	Switch	13.60	-	13	2	1
4730-542-3019		-[a]		13	2	1
6140-635-5208	Battery	13.46	-	13	4	1
2590-673-2211	Valve	191.43	-	13	1	1
1240-788-5453		-[a]		13	3	1
5995-789-7929		25.80	-	13	2	1
2530-845-4982	Cylinder	53.00	-	13	5	1
6140-897-6355	Adapter	6.27	-	13	1	1
2910-902-2869	Pump	56.59	-	13	1	1
2510-917-0952	U-bolt	.41	-	13	1	1
4720-930-7779	Engine assy	3500.00	-	13	2	1

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recoverability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
2510-933-3592	Spring assy	9.57	-	13	1	1
5355-937-0618	Knob	.65	-	13	2	1
2590-966-7392	Spring	.68	-	13	1	1
2910-770-1643	Hose assy	1.41	-	12	8	6
5340-678-1424	Plug	.08	-	12	7	5
2590-697-3713	Linkage	3.59	-	12	8	4
2930-734-5245	Pump, engine	12.23	-	12	8	4
2920-752-4258	Spark plugs	.48	-	12	4	4
2910-784-5351	Fuel pump	7.29	-	12	4	4
2590-906-0155	Distributor box	15.58	-	12	8	4
2530-064-6312	Pipe, exhaust	1.35	-	12	3	3
2520-073-0162	Hub assy	91.99	-	12	5	3
2530-736-4673	Gasket	.40	-	12	5	3
2520-806-1122	Shaft	47.17	-	12	4	3
5330-812-1373	Packing	.39	-	12	5	3
5930-849-8935	Switch	7.25	-	12	5	3
4720-869-0085	Tube assy	17.61	-	12	3	3
2920-933-3727	Starter	60.66	R	12	5	3
3110-939-7157	Rivet	.16	-	12	4	3
2995-954-3961	Actuator	191.00	R	12	6	3
3110-100-3679	Cone and roller	.98	-	12	3	2
5340-530-9628		a -		12	2	2
2940-555-6348	Filter element	1.98	-	12	6	2
2930-678-4671	Radiator	192.00	T	12	2	2
2520-690-1597	Propeller	22.63	-	12	2	2
2930-701-3912	Pulley, grooved	12.84	-	12	4	2
2990-737-2759	Pipe, exhaust	6.48	-	12	4	2
5930-878-4196	Switch	2.35	-	12	3	2
2520-895-9164		331.00	T	12	2	2
6125-916-9088	Motor gen	1204.00	S	12	6	2
2520-927-3331	Parts kit	2.74	-	12	3	2
2510-933-3710	Spring assy	25.96	-	12	2	2
2920-961-1436	Motor	127.00	-	12	4	2
1005-992-7289	Spring	.04	-	12	9	2
2805-999-2121	Filler	15.33	-	12	4	2
5315-010-3462	Key, Woodruff	.02	-	12	1	1
5305-022-3511	Screw	4.00	-	12	2	1
6685-033-0080		a -		12	2	1
2990-040-2333	Extension	3.01	-	12	1	1
5306-051-4078	Bolt, machine	2.81	-	12	1	1
5820-069-8931	Receiver	109.00	-	12	3	1
3110-142-4390	Cup and tape	2.91	-	12	4	1
4730-221-3902	Elbow, pipe	.19	-	12	2	1
2610-269-7332	Inner tube	2.99	-	12	3	1

Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recover-ability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
4820-287-4678	Tape	4.75	-	12	1	1
2910-358-4540	Carburetor	13.70	-	12	2	1
1005-608-5182	Sear	1.86	-	12	5	1
2920-679-8626	Arm	.05	-	12	2	1
2930-737-5626		-[a]		12	1	1
4730-867-2787		-[a]		12	2	1
1025-908-1610	Box assy	141.00	-	12	3	1
2530-927-3274	Master cyl	3.75	-	12	2	1
2530-933-3581	Brake drum	22.42	-	12	1	1
1240-963-0839	Telescope	506.00	R	12	6	1
2530-753-9267	Cylinder	12.70	-	11	8	8
2920-089-3607	Parts kit	6.63	-	11	9	6
2920-076-8993	Coil	4.47	-	11	8	5
2540-700-1055	Rod	.49	-	11	5	5
2520-706-1238	Seal, plain	.92	-	11	6	5
2805-737-5224	Gasket	3.98	-	11	7	5
2810-809-6914	Hose assy	1.20	-	11	5	5
2805-927-3298	Engine, gen	1082.00	T	11	10	5
2920-933-3720	Hose, pre	1.23	-	11	6	5
4730-999-2357	Elbow	8.52	-	11	6	5
6685-738-9567	Indicator	11.00	-	11	4	4
2930-832-5659	Pulley, grooved	5.97	-	11	4	4
2530-860-0572	Flange	5.11	-	11	5	4
2930-933-3721	Parts kit	22.82	-	11	6	4
2530-734-8898	Drag link	19.18	-	11	4	3
2920-735-9542	Relay	3.66	-	11	5	3
2530-737-9067	Spring	.23	-	11	5	3
2930-818-0373	Tensioner, fan	8.32	-	11	4	3
5306-832-5733	Bolt, ext	.21	-	11	6	3
5330-864-5776	Seal, oil	.87	-	11	6	3
3020-947-2143	Cone	3.11	-	11	5	3
2920-972-2598	Cable assy	8.83	-	11	4	3
5340-088-1879	Clevis rod	1.16	-	11	4	2
2530-167-8861	Lever	9.92	-	11	3	2
4720-288-7992	Hose, rubber	.79	-	11	3	2
2920-567-3235	Cable assy	20.73	-	11	2	2
2920-570-3057	Starter	206.00	-	11	5	2
2990-570-3080	Governor	20.40	-	11	2	2
4720-921-3620	Hose, rubber	.81	-	11	4	2
5305-018-0132	Screw, cap	.03	-	11	1	1
2530-040-2269	Link	.65	-	11	1	1
3110-188-1468		-[a]		11	1	1
2520-287-4673	Fitting	.09	-	11	1	1

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Table B9 (continued)

FSN of deadlining part	Noun	AMDF unit price	AMDF recoverability code	Equipment-weeks of deadline	Number of serial nrs deadlined	Number of units in which deadlined
5930-306-1937		-[a]		11	3	1
3110-327-2559		-[a]		11	1	1
3805-345-7871	Spool	1.60	-	11	1	1
5365-540-0784		-[a]		11	4	1
5305-639-8117		-[a]		11	1	1
2520-678-5653		-[a]		11	1	1
2805-734-5246	Manifold	10.50	-	11	4	1
2530-737-4765	Arm	8.03	-	11	1	1
2530-740-9381	Shield	18.90	-	11	1	1
6620-776-9962	Gage, pressure	5.16	-	11	2	1
5315-812-3764	Pin, straight	.03	-	11	1	1
1025-844-5351	Bracket	33.62	-	11	2	1
5820-868-8107	Transmitter	160.00	-	11	2	1
1025-872-0938	Pin assy	5.99	-	11	1	1
2920-882-3401	Starter	34.50	-	11	1	1
2520-930-2039	Pulley, grooved	34.92	-	11	1	1
2930-949-4202	Pump, water	6.94	-	11	2	1
2940-999-1285	Air cleaner	71.68	-	11	1	1

[a]Not on AMDF.

*Recoverability codes:[61]

D - Reparable item. When beyond lower level repair capability, return to depot. Condemnation and disposal not authorized below depot level.

R - Indicates repair parts and assemblies which are economically reparable at DSU and GSU activities and are normally furnished by supply on an exchange basis.

S - Indicates repair parts and assemblies which are economically reparable at DSU and GSU activities and which normally are furnished by supply on an exchange basis. When items are determined by a GSU to be uneconomically reparable, they will be evacuated to a depot for evaluation and analysis before final disposition.

T - Indicates high dollar value recoverable repair parts which are subject to special handling and are issued on an exchange basis. Such repair parts are normally repaired or overhauled at depot maintenance activities.

U - Repair parts specifically selected for salvage by reclamation units because of precious metal content, critical materials, or high dollar value reusable casings or castings.

Z - Nonreparable item. When unserviceable, condemn and dispose of at the level authorized to replace the item.

Appendix C

MAINTENANCE TAT DISTRIBUTIONS, MAN-HOUR DATA, AND TAMMS SUPPORT MAINTENANCE MEAN TIMES

Appendix C (continued)

RAC

INTRODUCTION

This appendix contains the more pertinent detailed data used as inputs to several of the analyses of maintenance presented in Chap. 5. There are three sets of data contained in this appendix.

Set one contains the detailed cumulative distributions (by 10 percentile increments) depicting the elapsed days to complete maintenance jobs. Each table shows a distribution for days awaiting shop, days in shop, and total elapsed repair cycle days. The individual elements of time are non-additive because each set of data is derived from a separate frequency distribution. Tables C1-C52 present the distributions for separate categories of equipment, e.g., automotive, electronics, engineer, etc., for each of the units examined. Tables C53-C61 present combined distributions, e.g., total DS automotive, total GS automotive.

The second set of tables constitutes input to the manpower utilization analysis. In order to arrive at a manpower utilization index a base number of annual available productive man-hours must be postulated. Tables C62 and C63 depict two estimates of annual available hours. These range from a high estimate of 1446 hours to a more conservative low estimate of 904 hours. Tables C64-C67 tabulate for each type of maintenance company in the RAC sample the number of direct labor personnel as extracted from the appropriate TOEs (references 7, 37 and 51 to 59). The number of maintenance man-hours recorded on the job order registers is summarized by category of maintenance for each of the DSUs/GSUs in Tables C68-C69.

The third set of data consists of Table C70 extracted from AR 750-1[9] which shows the mean support maintenance time for different elements of the repair cycle by selected equipment models. These turnaround times were computed using TAMMS data and are not intended to imply performance objectives.

Table C1

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Armament
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	1.5	.5	2.0
20	7.5	.5	9.0
30	8.5	.5	9.0
40	8.5	.5	9.0
50	9.5	.5	10.0
60	10.5	.5	11.0
70	27.5	.5	30.0
80	50.5	.5	53.0
90	90.5	.5	92.0
100	379.5	371.5	424.0

Table C2

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Armament
C Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	1.0
50	.5	.5	1.0
60	.5	.5	1.0
70	9.5	.5	14.0
80	27.5	.5	39.0
90	52.5	.5	53.0
100	365.5	147.5	366.0

Table C3

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Artillery
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	2.5	.5	4.0
40	5.5	.5	6.0
50	5.5	.5	6.0
60	7.5	.	9.0
70	12.5	.5	20.0
80	46.5	.5	47.0
90	46.5	.5	55.0
100	238.5	161.5	239.0

Table C4

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive (Wheel & Track)
A Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20.	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	2.0
50	.5	2.5	7.0
60	.5	6.5	12.0
70	.5	10.5	19.0
80	1.5	18.5	30.0
90	13.5	39.5	54.0
100	211.5	225.5	226.0

RAC

Table C5

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive (Wheel & Track)
C Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	1.5	4.0
30	2.5	2.5	9.0
40	6.5	2.5	14.0
50	9.5	2.5	20.0
60	16.5	3.5	26.0
70	23.5	4.5	32.0
80	32.5	7.5	42.0
90	43.5	19.5	57.0
100	226.5	255.5	256.0

Table C6

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive (Wheel & Track)
E Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	2.0
20	.5	.5	2.0
30	.5	1.5	4.0
40	1.5	2.5	7.0
50	2.5	2.5	8.0
60	4.5	3.5	12.0
70	8.5	5.5	18.0
80	18.5	6.5	28.0
90	31.5	11.5	44.0
100	276.5	334.5	335.0

Table C7

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	1.5	.5	2.0
30	3.5	.5	5.0
40	7.5	.5	8.0
50	11.5	.5	12.0
60	16.5	.5	18.0
70	25.5	.5	27.0
80	42.5	.5	43.0
90	72.5	.5	75.0
100	384.5	284.5	385.0

Table C8

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
C Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	2.5	.5	9.0
50	13.5	1.5	17.0
60	27.5	1.5	30.0
70	39.5	1.5	44.0
80	60.5	3.5	69.0
90	90.5	6.5	93.0
100	220.5	152.5	249.0

Table C9

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
8902d LS Co (LEM) (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	2.0
50	.5	.5	3.0
60	2.5	1.5	6.0
70	7.5	2.5	14.0
80	21.5	4.5	28.0
90	41.5	7.5	49.0
100	203.5	98.5	210.0

Table C10

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Aviation
B Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	1.5	2.0
30	.5	3.5	4.0
40	.5	5.5	7.0
50	.5	8.5	9.0
60	.5	11.5	12.0
70	.5	13.5	14.0
80	.5	16.5	17.0
90	.5	28.5	30.0
100	120.5	347.5	348.0

Table C11

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Aviation
B Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	.5	2.0
40	.5	.5	3.0
50	1.5	1.5	5.0
60	1.5	1.5	7.0
70	2.5	4.5	12.0
80	5.5	9.5	23.0
90	11.5	30.5	43.0
100	373.5	252.5	374.0

Table C12

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Chemical
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	1.5	.5	19.0
40	3.5	.5	25.0
50	14.5	.5	41.0
60	21.5	.5	54.0
70	41.5	11.5	74.0
80	102.5	22.5	120.0
90	180.5	49.5	191.0
100	395.5	206.5	396.0

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Table C13

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
A Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.C
20	.5	.5	2.0
30	.5	.5	3.0
40	.5	1.5	5.0
50	.5	3.5	8.0
60	.5	6.5	13.0
70	1.5	13.5	22.0
80	4.5	24.5	36.0
90	12.5	51.5	62.0
100	154.5	289.5	306.0

Table C14

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
C Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	1.5	2.0
30	.5	1.5	3.0
40	.5	1.5	4.0
50	1.5	1.5	6.0
60	4.5	1.5	7.0
70	7.5	2.5	10.0
80	13.5	3.5	16.0
90	28.5	5.5	31.0
100	215.5	58.5	218.0

Table C15

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
E Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	.5	4.0
30	1.5	1.5	6.0
40	2.5	2.5	8.0
50	5.5	2.5	12.0
60	8.5	4.5	17.0
70	14.5	5.5	27.0
80	26.5	7.5	42.0
90	60.5	17.5	78.0
100	310.5	118.5	315.0

Table C16

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
C Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	1.5	.5	3.0
40	4.5	.5	6.0
50	7.5	.5	10.0
60	12.5	.5	15.0
70	17.5	.5	22.0
80	24.5	.5	35.0
90	43.5	8.5	62.0
100	292.5	254.5	309.0

RAC

Table C17

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
A Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	2.5	10.0
50	.5	9.5	23.0
60	.5	22.5	40.0
70	.5	49.5	65.0
80	.5	151.5	162.0
90	6.5	279.5	280.0
100	223.5	396.5	397.0

Table C18

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	.5	3.0
40	.5	.5	5.0
50	2.5	.5	6.0
60	5.5	.5	12.0
70	12.5	1.5	14.0
80	14.5	3.5	29.0
90	42.5	7.5	56.0
100	354.5	179.5	421.0

Table C19

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Fuel and Electrical
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	1.5	.5	3.0
30	2.5	.5	5.0
40	3.5	.5	6.0
50	4.5	.5	7.0
60	6.5	1.5	9.0
70	8.5	1.5	13.0
80	14.5	3.5	18.0
90	29.5	6.5	34.0
100	161.5	191.5	260.0

Table C20

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Instruments
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	1.5	.5	4.0
50	4.5	.5	7.0
60	7.5	.5	12.0
70	12.5	.5	19.0
80	22.5	.5	37.0
90	51.5	12.5	63.0
100	370.5	330.5	387.0

Table C21

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Calibration
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	6.0
20	15.5	.5	18.0
30	17.5	.5	18.0
40	17.5	.5	23.0
50	23.5	.5	24.0
60	32.5	.5	32.0
70	32.5	.5	32.0
80	32.5	1.5	32.0
90	94.5	11.5	127.0
100	263.5	69.5	264.0

Table C22

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
A Co 124th Maint Bn (DS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	2.0
50	.5	.5	4.0
60	.5	1.5	6.0
70	1.5	3.5	9.0
80	3.5	6.5	15.0
90	10.5	16.5	28.0
100	125.5	150.5	152.0

Table C23

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	1.5	.5	2.0
40	4.5	.5	5.0
50	9.5	.5	11.0
60	15.5	.5	16.0
70	27.5	.5	29.0
80	45.5	.5	48.0
90	83.5	.5	85.0
100	399.5	230.5	400.0

Table C24

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
C Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	1.5	.5	2.0
40	10.5	.5	11.0
50	22.5	.5	30.0
60	46.5	.5	53.0
70	66.5	.5	78.0
80	115.5	.5	127.0
90	165.5	1.5	182.0
100	346.5	243.5	347.0

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Table C25

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
8902d LS Co (LEM) (DS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	.5	5.0
50	1.5	.5	8.0
60	9.5	.5	14.0
70	19.5	1.5	23.0
80	30.5	3.5	35.0
90	51.5	6.5	55.0
100	147.5	98.5	148.0

Table C26

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Small Arms
A Co 123d Maint Bn (DS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20.	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	1.0
50	.5	.5	1.0
60	.5	.5	2.0
70	4.5	.5	6.0
80	12.5	.5	21.0
90	37.5	.5	50.0
100	363.5	119.5	424.0

Table C27

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Small Arms
8902d LS Co (LEM) (DS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	1.0
50	.5	.5	2.0
60	.5	1.5	2.0
70	.5	1.5	4.0
80	1.5	2.5	4.0
90	4.5	3.5	8.0
100	96.5	36.5	99.0

Table C28

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Armament
42d HEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	.5	3.0
50	1.5	.5	7.0
60	2.5	1.5	14.0
70	6.5	7.5	25.0
80	7.5	22.5	32.0
90	28.5	24.5	43.0
100	156.5	266.5	366.0

Table C29

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive (Wheel & Track)
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	4.0
20	.5	1.5	6.0
30	1.5	2.5	8.0
40	2.5	3.5	10.0
50	4.5	4.5	14.0
60	6.5	7.5	20.0
70	8.5	12.5	29.0
80	15.5	19.5	44.0
90	35.5	41.5	71.0
100	132.5	201.5	233.0

Table C30

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
42d HEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	.5	2.0
50	.5	1.5	6.0
60	1.5	4.5	8.0
70	3.5	5.5	14.0
80	6.5	11.5	21.0
90	14.5	17.5	32.0
100	96.5	55.5	104.0

Table C31

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	2.5	3.0
20	.5	2.5	3.0
30	.5	3.5	4.0
40	.5	4.5	5.0
50	.5	5.5	6.0
60	.5	7.5	8.0
70	.5	9.5	10.0
80	.5	12.5	13.0
90	.5	21.5	26.0
100	31.5	168.5	169.0

Table C32

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Calibration
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	.5	7.0
30	3.5	1.5	13.0
40	6.5	2.5	18.0
50	8.5	4.5	18.0
60	11.5	6.5	33.0
70	21.5	11.5	38.0
80	32.5	19.5	42.0
90	39.5	37.5	57.0
100	81.5	100.5	101.0

Table C33

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Calibration
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days: Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	12.5	13.0
30	.5	15.5	16.0
40	.5	19.5	21.0
50	.5	24.5	25.0
60	.5	27.5	28.0
70	.5	29.5	30.0
80	.5	35.5	36.0
90	.5	39.5	40.0
100	3.5	63.5	64.0

Table C34

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Chemical
182d LEM Co (GS)
USAREUR

Cumulative percent	Days: Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	1.5	.5	2.0
30	1.5	.5	3.0
40	1.5	.5	3.0
50	2.5	.5	4.0
60	3.5	1.5	6.0
70	4.5	1.5	8.0
80	5.5	3.5	12.0
90	9.5	11.5	22.0
100	205.5	136.5	206.0

Table C35

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

DX Component Repair
42d HEM Co (GS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	1.5	.5	2.0
20	3.5	.5	4.0
30	7.5	.5	8.0
40	11.5	.5	12.0
50	16.5	.5	17.0
60	23.5	.5	24.0
70	32.5	.5	33.0
80	47.5	.5	48.0
90	72.5	.5	73.0
100	368.5	80.5	369.0

Table C36

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

DX Component Repair
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	2.5	3.0
20	.5	3.5	4.0
30	.5	4.5	5.0
40	.5	6.5	7.0
50	.5	7.5	8.0
60	.5	11.5	12.0
70	.5	14.5	15.0
80	.5	20.5	22.0
90	.5	29.5	32.0
100	206.5	137.5	210.0

Table C37

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

DX Component Repair
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	-[a]	-[a]	3.0
20	-[a]	-[a]	4.0
30	-[a]	-[a]	6.0
40	-[a]	-[a]	7.0
50	-[a]	-[a]	9.0
60	-[a]	-[a]	12.0
70	-[a]	-[a]	17.0
80	-[a]	-[a]	26.0
90	-[a]	-[a]	41.0
100	-[a]	-[a]	394.0

[a] One portion of the DX job-order register recorded only receipt to completion dates.

Table C38

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
182d LEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	1.5	.5	2.0
40	1.5	.5	3.0
50	1.5	.5	5.0
60	3.5	1.5	7.0
70	4.5	3.5	9.0
80	5.5	9.5	19.0
90	8.5	34.5	39.0
100	244.5	202.5	283.0

Table C39

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
3905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days: Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	1.5	2.0
40	.5	2.5	3.0
50	.5	5.5	6.0
60	.5	8.5	9.0
70	.5	13.5	14.0
80	.5	22.5	23.0
90	.5	42.5	43.0
100	100.5	204.5	205.0

Table C40

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days: Awaiting shop	In shop	Turnaround time
10	.5	.5	7.0
20.	.5	1.5	9.0
30	1.5	3.5	13.0
40	3.5	6.5	19.0
50	5.5	8.5	23.0
60	8.5	11.5	31.0
70	11.5	21.5	50.0
80	21.5	37.5	75.0
90	54.5	82.5	97.0
100	121.5	315.5	317.0

Table C41

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
42d HEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	.5	3.0
30	.5	1.5	5.0
40	.5	4.5	5.0
50	.5	4.5	7.0
60	.5	6.5	8.0
70	.5	8.5	10.0
80	1.5	13.5	15.0
90	5.5	28.5	29.0
100	11.5	95.5	96.0

Table C42

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
132d LEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	1.0
50	.5	.5	1.0
60	.5	.5	2.0
70	1.5	1.5	5.0
80	2.5	4.5	6.0
90	4.5	10.5	13.0
100	61.5	223.5	225.0

Table C43

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	1.5	2.0
20	.5	2.5	3.0
30	.5	3.5	4.0
40	.5	4.5	5.0
50	.5	5.5	6.0
60	.5	6.5	7.0
70	.5	9.5	10.0
80	.5	20.5	21.0
90	.5	45.5	48.0
100	52.5	321.5	322.0

Table C44

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Fuel & Electrical
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	3.0
20	.5	1.5	6.0
30	1.5	2.5	7.0
40	1.5	4.5	9.0
50	2.5	5.5	12.0
60	5.5	6.5	16.0
70	7.5	8.5	18.0
80	12.5	12.5	24.0
90	20.5	23.5	46.0
100	240.5	232.5	253.0

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Table C45

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Fuel and Electrical
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	1.5	2.0
20	.5	2.5	3.0
30	.5	3.5	4.0
40	.5	4.5	5.0
50	.5	6.5	7.0
60	.5	7.5	8.0
70	.5	10.5	11.0
80	[illegible]	15.5	16.0
90	.5	27.5	28.0
100	21.5	131.5	132.0

Table C46

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Instruments
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	3.0
20	.5	1.5	7.0
30	1.5	2.5	11.0
40	1.5	5.5	16.0
50	2.5	8.5	23.0
60	5.5	14.5	33.0
70	8.5	24.5	40.0
80	13.5	40.5	53.0
90	29.5	61.5	69.0
100	181.5	206.5	211.0

Table C47

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Quartermaster
182d LEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	1.0
40	.5	.5	2.0
50	.5	.5	4.0
60	1.5	1.5	6.0
70	2.5	3.5	11.0
80	5.5	11.5	18.0
90	10.5	42.5	51.0
100	65.5	197.5	205.0

Table C48

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	.5	3.0
30	.5	.5	4.0
40	.5	1.5	6.0
50	1.5	2.5	8.0
60	4.5	3.5	12.0
70	6.0	5.5	15.0
80	11.5	8.5	22.0
90	19.5	16.5	31.0
100	123.5	104.5	124.0

Table C49

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
182d LEM Co (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	.5	2.0
40	1.5	.5	2.0
50	1.5	.5	3.0
60	1.5	1.5	4.0
70	2.5	1.5	5.0
80	3.5	3.5	8.0
90	6.5	8.5	15.0
100	80.5	159.5	162.0

Table C50

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Service Shop
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	1.5	2.0
20	.5	3.5	[illegible]
30	.5	4.5	5.0
40	.5	7.5	8.0
50	.5	14.5	15.0
60	.5	23.5	25.0
70	.5	32.5	33.0
80	.5	43.5	44.0
90	.5	58.5	60.0
100	70.5	96.5	97.0

Table C51

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Small Arms
190th HEM Co (GS)
Ft. Hood

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	1.5	3.0
20	.5	1.5	5.0
30	1.5	2.5	8.0
40	1.5	4.5	14.0
50	4.5	6.5	17.0
60	7.5	9.5	20.0
70	9.5	13.5	23.0
80	12.5	15.5	26.0
90	20.5	18.5	31.0
100	127.5	64.5	130.0

Table C52

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Test Equipment (Elect)
8905th LS Co (LEM) (GS)
USAREUR

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	1.5	2.0
40	.5	2.5	3.0
50	.5	4.5	5.0
60	.5	5.5	6.0
70	.5	8.5	9.0
80	.5	18.5	19.0
90	.5	38.5	39.0
100	8.5	189.5	190.0

Table C53

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
Direct Support Units

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	.5	4.0
50	2.5	.5	8.0
60	6.5	1.5	13.0
70	14.5	2.5	22.0
80	25.5	4.5	36.0
90	49.5	10.5	59.0
100	384.5	334.5	385.0

Table C54

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Aviation
Direct Support Units

Cumulative percent	Days: Awaiting shop	Days: In shop	Days: Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	1.5	3.0
40	.5	2.5	5.0
50	.5	4.5	7.0
60	.5	7.5	10.0
70	.5	11.5	14.0
80	1.5	15.5	19.0
90	4.5	29.5	35.0
100	373.5	347.5	374.0

Table C55

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
Direct Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	.5	3.0
40	.5	1.5	5.0
50	.5	2.5	8.0
60	1.5	5.5	13.0
70	3.5	9.5	22.0
80	7.5	20.5	35.0
90	19.5	45.5	62.0
100	310.5	289.5	315.0

Table C56

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
Direct Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	3.0
40	.5	.5	6.0
50	.5	1.5	11.0
60	1.5	1.5	16.0
70	6.5	5.5	31.0
80	13.5	20.5	54.0
90	40.5	93.5	165.0
100	354.5	396.5	421.0

Table C57

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Automotive
General Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	2.0
20	.5	1.5	4.0
30	.5	2.5	6.0
40	.5	3.5	7.0
50	1.5	4.5	10.0
60	2.5	6.5	13.0
70	5.5	9.5	20.0
80	9.5	15.5	31.0
90	22.5	29.5	51.0
100	132.5	201.5	233.0

Table C58

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

DX Components
General Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	3.0
20	.5	.5	4.0
30	.5	.5	7.0
40	3.5	5	9.0
50	7.5	.5	14.0
60	13.5	.5	19.0
70	21.5	.5	28.0
80	34.5	4.5	39.0
90	59.5	12.5	67.0
100	368.5	137.5	369.0

Table C59

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Electronics
General Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	2.0
30	.5	.5	2.0
40	.5	.5	3.0
50	.5	1.5	5.0
60	1.5	3.5	7.0
70	1.5	7.5	11.0
80	3.5	17.5	21.0
90	6.5	37.5	42.0
100	244.5	204.5	283.0

Table C60

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Engineer
General Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	.5	1.0
20	.5	.5	1.0
30	.5	.5	2.0
40	.5	1.5	3.0
50	.5	2.5	4.0
60	.5	4.5	6.0
70	.5	6.5	8.0
80	.5	11.5	15.0
90	3.5	31.5	37.0
100	121.5	321.5	322.0

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Table C61

ELAPSED DAYS TO COMPLETE MAINTENANCE JOBS

Fuel & Electrical
General Support Units

Cumulative percent	Days		
	Awaiting shop	In shop	Turnaround time
10	.5	1.5	2.0
20	.5	2.5	3.0
30	.5	3.5	5.0
40	.5	4.5	6.0
50	.6	5.5	7.0
60	.5	7.5	9.0
70	.5	9.5	12.0
80	.5	15.5	18.0
90	1.5	26.5	2[illegible].0
100	240.5	232.5	253.0

Table C62

ANNUAL PRODUCTIVE MAINTENANCE MAN-HOURS

High Estimate

Activity	Hours
Total time available (260 days x 8 hours)	2,080
Holidays (9 per year)	- 72
	2,008
Leave (10%)	- 201
	1,807
Miscellaneous non productive time (20%)	- 361
Annual available productive man-hours	1,446

Table C63

ANNUAL PRODUCTIVE MAINTENANCE MAN-HOURS

Low Estimate

Activity	Hours
Total time available (365 x 8 hours)	2,920
Saturdays, Sundays, holidays	- 704
	2,216
Pass and leave	- 208
	2,008
Miscellaneous nonproductive time (55%)[a]	-1,104
Annual available productive man-hours	904

[a]Miscellaneous nonproductive time:

TOE maintenance	400 hours
Training	224 hours
Details	160 hours
Army training tests and operational readiness training	104 hours
Pay days	96 hours
Inspections	64 hours
Athletics and recreation	56 hours

Table C64

DIRECT LABOR PERSONNEL

Headquarters and Main Support Company
Maintenance Battalion, Armored Division

Maintenance section	Direct labor personnel		
	TOE 29-36E	TOE 29-36G	TOE 29-38H
Armament	15	17	41
Electronics	51	42	-
Mechanical	255	163	134
Service	13	12	14
Total	334	234	189

Table C65

DIRECT LABOR PERSONNEL

Forward Support Company
Maintenance Battalion, Armored Division

Maintenance section	Direct labor personnel		
	TOE 29-37E	TOE 29-37G	TOE 29-37H
Armament	-	-	24
Electronics	-	-	7
Mechanical	43	73	77
Service	6	6	-
Total	49	79	108

Table C66

DIRECT LABOR PERSONNEL

Transportation Aircraft Maintenance Company
Maintenance Battalion, Armored Division

Maintenance section	Direct labor personnel	
	TOE 55-454G	TOE 55-424H
Rotary wing section	11	18
Main support platoon	21	26
Total	32	44

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Table C67

DIRECT LABOR PERSONNEL

General Support Maintenance Companies

Maintenance section	Direct labor personnel		
	LEM TOE 29-134G	HEM TOE 29-137G	Labor service TOE 29-449G
Artillery	-	7	
Automotive	-	95	
Chemical	28	-	
Components	-	18	
Electrical	30	-	
Engineer (hvy equip)	-	20	
Instruments	-	9	
Quartermaster	15	-	
Radar-Instruments	14	-	
Radio-Carrier	20	-	
Service	21	22	
Small arms	-	6	
Special equipment	27[a]	6[b]	
Telephone-Telegraph items	12	-	
Labor Service[c]			136
Total	167	183	136

[a]Includes ADP, refrigeration, reproduction, and topographic instrument equipment repair.

[b]Includes QM heavy equipment and chemical equipment repair.

[c]TOE does not provide specific details concerning composition when organized for maintenance mission.

Table C68

ANNUAL MAINTENANCE MAN-HOURS

Direct Support Companies

Maintenance section	Man-hours recorded by DS companies							
	A/123	B/123	C/123	A/124	B/124	C/124	E/124	8902 LS
Armament	528[a]	-	727	-	-	-	-	-
Artillery	1,497[a]	-	-	-	-	-	-	-
Automotive	12,263[b]	-	1,450	5,296[b]	-	10,682	1,971	49,356
Aviation	-	11,889	-	-	22,113	-	-	-
Calibration	259[c]	-	-	-	-	-	-	-
Chemical	532[b]	-	-	-	-	-	-	-
Electronics	-	-	945	12,906	-	632	1,509	-
Engineer	916[b]	-	-	1,807[b]	-	-	-	-
Fuel & Electrical	3,260[b]	-	-	-	-	-	-	-
Instruments	2,908[b]	-	-	-	-	-	-	-
Service	4,981	-	436	2,890	-	-	-	30,498
Small arms	2,435[a]	-	-	-	-	-	-	6,731
Total	29,579	11,889	3,558	22,899	22,113	11,314	3,480	86,585

[a]Included under "Armament" category.

[b]Included under "Mechanical" category.

[c]Not included in utilization table.

Table C69

ANNUAL MAINTENANCE MAN-HOURS

General Support Companies

Maintenance section	Man-hours recorded by GS companies			
	42d HEM	190th HEM	182d LEM	8905th LS (LEM)
Armament	2,527	-	-	-
Automotive	6,361	4,727	-	5,052
Calibration	-	192[a]	-	561
Chemical	-	-	3,571	-
DX components	5,334	2,664	-	5,662
Electronics	-	-	31,346[b]	41,007
Engineer	7,766	1,147	18,794[b]	25,903
Fuel & Electrical	-	-	-	29,710
Instruments	-	1,949	-	-
Quartermaster	-	-	6,511	-
Service	-	4,044	5,475	5,978
Small arms	-	453	-	-
Test equipment	-	-	-	4,483
Total	21,988	15,176	65,697	118,366

[a]Included in "Instrument" category.

[b]Included in "Other" category.

Table C70

SUPPORT MAINTENANCE MEAN TIME TO REPAIR
(Extracted from AR 750-1)

Days in Transit (DIT), Days Awaiting Repair (DAR), Days in Shop (DIS)

Equipment Category	USAREUR			USARPAC*			USARAL			CONARC		
	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS
AIRCRAFT, ROTARY WING												
Helicopter Utility	1	1	5	1	1	2	1	1	7	2	2	5
Helicopter Observation	1	1	5	1	1	3	1	1	7	1	2	5
Helicopter Transport				1	1	2				2	2	2
Helicopter Attack				1	1	2				2	2	2
AIRCRAFT, FIXED WING												
Airplane, Observation	2	1	4	1	1	2	2	1	4	2	2	3
Airplane, Utility	2	1	4	1	1	3	1	1	5	2	2	5
ARTILLERY												
Howitzer LT TWD	2	3	6	2	6	4	3	15	5	1	4	4
Howitzer MED TWD				3	4	14				2	3	2
Mortars	3	10	5	2	6	5	1	21	2	4	3	2
Rifle Recoilless	3	15	5	1	1	5	3	7	2	2	5	2
COMBAT VEHICLES												
ARAAV				5	5	6	3	9	10	5	2	2
Carrier, Cargo	3	12	12	2	6	4	2	10	3	5	2	2
Carrier, C&R	5	10	3	4	14	2	2	10	10	2	20	10
Carrier, CP	4	12	12	3	5	2	2	10	7	6	20	8
Carrier, Personnel	2	1	8	2	2	1	3	10	2	6	8	12
Combat Engr Veh	4	12	10							6	8	7
Howitzer SP 105 mm	4	2	8	2	2	1	2	6	5	8	5	5
Howitzer SP 155 mm	3	12	3	2	1	2	2	15	5	2	6	6
Howitzer SP 8-Inch	3	12	3	4	4	2				2	3	8
Gun, SP 40 mm				2	2	1				2	6	8
Gun, SP 175 mm	3	8	3	2	2	1				2	6	4

Table C70 (continued)

Equipment Category	USAREUR			USARPAC*			USARAL			CONARC		
	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS
Mortar, SP 81 mm	2	15	7	3	6	2	1	12	4	4	6	6
Mortar, SP 107 mm	2	7	6	2	1	1	1	15	4	6	5	5
Tank, Combat M48-series				2	2	2				5	6	7
Tank, Combat M60-series	5	6	2							6	10	5
Tank, Recovery Veh Lt	5	15	10	2	4	4	3	12	4	2	7	15
Tank, Recovery Veh Med	5	16	10	1	12	6				6	8	5
COMMO--ELECTRONIC EQP												
Radar Set AN/MPQ-4A	3	7	2	2	2	2				1	2	1
Radar Set AN/PPS-4, 4A&5	3	5	7	6	3	6	4	5	7	5	10	10
Radio TT Set	8	10	10	2	10	12	1	2	10	5	6	11
Radio Terminal Set	3	3	14	2	2	11				3	1	18
Radio Set AN/GRC-106				3	1	1				3	1	1
Radio Set AN/PRC-25, -77				1	7	10				2	6	4
CONSTRUCTION EQP												
Crane-shovel Crwlr Mtd	1	2	6	4	6	7				3	13	10
Crane-shovel Trk Mtd	3	5	18	3	14	5	2	14	15	2	14	22
Grader Road, Motorized	6	14	17	2	6	7	4	15	20	2	8	20
Loader Scoop Self-Pwrd	8	18	20	2	6	6				2	12	19
Tractor Ft Hvy	2	20	23	4	9	6	5	14	14	2	3	8
Tractor Ft Med	4	8	20	6	6	5	2	10	15	2	11	14
Tractor Wheeled DED	4	10	15	3	4	4	4	7	13	6	18	13
MATERIELS HANDLING EQP												
Truck Lift Fork RT, Gasoline-engine driven	6	18	17	2	9	15	2	10	6	4	18	15
Truck Lift Fork RT, Diesel-engine driven	2	4	3	2	3	3				2	7	14
SMALL ARMS												
Flamethrower	5	2	1	2	1	2				2	2	6
Generator Smoke Mech	4	2	10	3	10	5				6	6	9

RAC

Table C70 (continued)

Equipment Category	USAREUR			USARPAC*			USARAL			CONARC		
	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS	DIT	DAR	DIS
SUPPORT EQP												
Generator Under 5KW	4	10	13	5	9	5	5	6	2	4	11	6
Generator 5KW & over DC	3	7	1	5	5	3				2	2	2
Generator 5KW & over AC 60CY	4	5	13	3	6	6	3	22	15	2	5	9
Generator 5KW & over AC 400CY	4	9	14	6	8	6	4	10	9	6	7	13
Generator Gas Turbine	4	6	1	2	6	4				2	2	3
Compressor Air 105CFM & over	4	20	15	5	8	6	4	11	12	2	5	14
Lube Svc Unit Pwr OP	5	16	16	5	15	2	4	12	7	5	15	2
Water Purification Set	1	5	21	2	5	7				5	1	15
TACTICAL & SUPPORT VEH												
Truck under $2\frac{1}{2}$T	3	10	5	2	4	2	2	10	2	4	8	6
Truck Cargo $2\frac{1}{2}$T	6	14	14	6	6	4	4	18	1	3	10	8
Truck Cargo 5T	8	22	18	2	3	2	4	13	12	6	7	9
Truck Tractor $2\frac{1}{2}$T	3	11	17	5	9	5				3	12	1
Truck Tractor 5T	4	15	11	3	10	6	3	1	10	6	10	10
Truck Tractor 10T	5	22	31	2	9	4	3	6	11	2	11	14
Truck Wrkr $2\frac{1}{2}$T	4	14	18	2	10	2	2	1	3	4	9	3
Truck Wrkr 5T	4	24	20	2	5	2	2	18	3	6	9	15
Truck Tank $2\frac{1}{2}$T	4	14	21	3	8	8	2	14	12	4	9	15
Truck Bolster $2\frac{1}{2}$T				1	1	1				1	9	3
Truck Dump $2\frac{1}{2}$T	2	4	5	3	4	2				5	12	8
Truck Dump 5T	3	5	7	2	4	2	3	8	6	7	4	4
WATERCRAFT												
Lighter, Amphib LARC-V				2	10	1				2	2	18
Lighter, Amphib LARC-XV										2	1	2

*Includes RVN.

Note: The times in this table were developed from TAMMS data.

addition criterion. The minimum number of demands required in the control period for addition of a line to the stockage list.

addition-retention criteria. See "addition criterion" and "retention criterion".

Army Master Data File (AMDF). The official source of supply data for lines managed or used by the Army.

authorized stockage list (ASL). A list of the lines authorized for stockage at the direct support level.

coefficient of correlation. A statistical term that denotes the degree to which the observed variations in the dependent variable may be related to variations in the independent variable, for a curvilinear function. It is defined as the ratio of the standard deviation from observed values of the dependent variable to the standard deviation of the independent variable. A ratio of ± 1 is termed perfect correlation.

control period. That period of time for which factors were determined for use in current planning and programming. With regard to overseas stockage policy, usually one year.

customer. See "user-unit".

deadline. To remove a vehicle or piece of equipment from operation or use for one of the following reasons: a. inoperative due to damage, malfunctioning, or necessary repairs. The term does not include items temporarily removed from use by reason of routine maintenance, and repairs which do not affect the combat capability of the item; b. unsafe; c. would be damaged by further use.

demand accommodation. The percent of total valid demands received that match the lines on the authorized stockage list.

Direct Support System (DSS). The supply concept in which a large portion of a DSU's repair parts requirements are met by direct supply from CONUS.

economic order quantity (EOQ). A quantity of repair parts/supplies established for each line based on the relation of variable cost to hold assets vs variable cost to buy, resulting in an optimum order quantity at a minimum total cost.

equipment readiness. The availability of equipment required by military organizations to support wartime activities or contingencies.

holding cost factor. A factor used to determine the costs associated with the physical presence of materiel in inventory. Generally expressed as an annual percentage of average inventory investment.

index of determination. An indicator that determines how well a regression line fits the observed data. It is computed by squaring the coefficient of correlation. Its value may vary from zero to one; the closer to one, the better the fit. The index of determination is preferred to the coefficient of correlation for most applications in business and economics because it is a more clear-cut way of stating

the proportion of the variance in the dependent variable that is associated with the independent variable.[62]

national inventory control point (NICP). An activity responsible for the worldwide management of inventories of assigned commodities. This responsibility includes worldwide asset accounting, requirements computation, and direction of procurement, distribution, overhaul, and disposal.

nonstockage list (NSL). Lines authorized for issue to the requesting organization but not meeting the demand criterion for stockage at the organization and not qualifying for inclusion on the stockage list for other reasons.

operating level (OL). The quantity of repair parts/supplies required to sustain operations in the interval between requisitions or the arrival of successive shipments.

order shipping time (OST) quantity. The portion of the RO that represents the quantity of stock that will normally be consumed during the elapsed time between the initiation of stock replenishment action and the receipt of materiel.

ordering cost. As used in this report, the cost involved in processing a requisition.

prescribed load list (PLL). A list that indicates the quantities of repair parts and maintenance-related supplies required to be on hand at organizational level. Normally this is considered to be 15 days of supply.

reorder point (RP). The level of inventory at which stock replenishment requisitions are submitted.

requisitioning objective (RO). The maximum quantity of repair parts/supplies to be maintained on hand and on order to sustain current operations. The RO consists of the sum of stocks represented by the SL, OL, and OST levels.

retention criterion. The minimum number of demands required in the control period for retention of a line on the stockage list at a supply point, once it has been added.

review interval. The elapsed time between reviews of demand history for the purpose of adding or deleting items from the stockage list.

safety level (SL). The quantity of repair parts/supplies, in addition to the operating level, required to be on hand to permit continuous operations in the event of minor interruption of normal replenishment or unpredictable fluctuations in demand.

standard deviation. A statistical measure of the variation of a group of observations around the mean of the group. It is computed by adding the squares of the deviations of each observation from the group mean, dividing the result by the sample size, and computing the square root of that result.[62]

stockage breadth. The number of different lines selected for stockage on the basis of demand frequency.

stockage criteria. The rules that govern what lines will be maintained on the stockage list at a supply point. Stockage criteria are composed of addition criterion and retention criterion.

stockage depth. The quantity of items stocked at a particular supply echelon, also expressed as days of supply.

TRICAP (triple capability). An organization consisting of three basic combat elements: armor, airmobile infantry, and air cavalry with attack helicopters.

turbulence. The degree of fluctuation experienced by a stockage list, measured by the sum of annual additions and deletions to the list expressed as a percent of list size.

turnaround time (TAT). The elapsed time constituting the maintenance repair cycle. TAT begins with receipt of the job at the maintenance unit and ends with completion of the job.

user unit. The organizational units supported by the direct and general support levels.

REFERENCES

CITED REFERENCES

1. Leon N. Karadbil, et al, "Logistics of a Combat Division," RAC-TP-292, Research Analysis Corporation, Jan 68.
2. Research Analysis Corporation, "Study Work Statement, 012.112," 23 Jul 71.
3. Dept of Army, "Logistics Improvements," DA Cir 700-18, 7 May 71.
4. Dept of Defense, "Procurement Cycles and Safety Levels of Supply for Secondary Items," DOD Instruction 4140.39, 17 Jul 70.
5. Dept of Army, "Logistics Performance Measurement and Evaluation System," AR 11-10, Nov 70.
6. ______, "Maintenance of Supplies and Equipment, Equipment Operationally Ready Standards," AR 750-52, 15 Oct 71.
7. ______, "Headquarters and Main Support Company, Maintenance Battalion, Armored Division," TOE 29-36E, 15 Jul 63.
8. ______, "Inventory Management, Materiel Management for Using Units, Support Units, and Installations," AR 710-2, Aug 71.
9. ______, "Army Materiel Maintenance Concepts and Policies," AR 750-1, May 72.
10. ______, "Dictionary of United States Army Terms," AR 310-25, Mar 69.
11. US Army Materiel Command Logistics Data Center, "Unit Equipment Status and Serviceability Report," RCS-CSGLD-1237, Lexington, Ky, published quarterly.
12. Dept of Army "Inventory Management, Materiel Management for Using Units, Support Units, and Installations," AR 710-2, Change 1, 7 Mar 72.
13. US Army, Europe, "USAREUR Suppl 1 to AR 710-2, Annex B, Quick Supply Store Procedures," no date.
14. Leon N. Karadbil, et al, "A Basis for Establishing Order Shipping Time (OST) Standards for the Direct Support System," Research Analysis Corporation, RAC-CR-65, Sep 72.
15. Dept of Army, "Maintenance Support Positive (MS+) Army Maintenance for the Seventies," DA Cir 750-34, 19 Aug 73.
16. V. James Wennergren, "Development of Division Logistics System Direct Exchange Procedures," Dept of Army, US Army Logistics Doctrine, Systems and Readiness Agency, New Cumberland, Pa, Oct 70
17. Dept of Army, "Maintenance Float Support of Army Materiel," AR 750-19, 24 Apr 70.
18. Leon N. Karadbil, et al, "A Stockage Criteria Model Applied to Army Supply Management," RAC-TP-435, Vols I and II, Research Analysis Corporation, Nov 71.

19. John R. Bossenga, et al, "An Analysis of Alternative Procedures for Developing Prescribed Load Lists (PLLs)," RAC-R-31, Vols I and II, Research Analysis Corporation, Jan 68.

20. Dept of Army, "Requisitioning, Receipt, and Issue System," AR 725-50, Feb 65.

21. Leon N. Karadbil, et al, "The Effects of Control Period and Review Interval on Selected Measures of Supply Performance," RAC-TP-453, Sep 72.

22. General Electric Corporation, Information Service Department, "User's Guide, Regression Analysis--Mark I," Publication Number 5022lGA, Bethesda, Md, Feb 70.

23. Acheson J. Duncan, <u>Quality Control and Industrial Statistics</u>, Richard D. Irwin, Inc, Homewood, Ill, 1955.

24. Dept of Army, "Disposal of Excess, Surplus, Foreign Excess, Captured, and Unwanted Materiel," AR 755-2, Jul 70.

25. GEN Frank S. Besson (USA-Ret) to L. N. Karadbil, Memo, subject: "Log Performance Standards," 10 Apr 72.

26. Dept of Army, DCSLOG, "In Process Review of Direct Support System, Europe," 8-16 May 72.

27. _____, "Procedures for Direct Supply Support Test" (US Army, Europe), 5 May 70.

28. _____, "Logistics, Selective Management of Secondary Items," FM 38-22, Dec 65.

29. Logistics Management Institute, "Economic Order Quantities at Army Overseas Direct Support Units and Depots," LMI Task 70-9, Oct 70.

30. US Air Force, "US Air Force Supply Manual," AFM 67-1, Vol II, part 2, 1 Jul 71.

31. Edward A. Markham and LTC Norman C. Blahuta, "Costs of Repair-Parts Supply Operations in a Combat Division," RAC-TP-356, Research Analysis Corporation, Aug 69.

32. Herbert Arkin and Raymond R. Colton, <u>Statistical Methods</u>, College Outline Series, Barnes and Noble, New York, 1959.

33. Dept of Army, US Army Logistics Doctrine, Systems and Readiness Agency, "Quick Supply (QS) Stores (at DSU Level)," Draft Procedures, New Cumberland, Pa, Aug 71.

34. _____, DCSLOG-SPD, Message to Major Overseas Commands, subject: "Logistics Improvements," 15 Sep 71.

35. US Army, Europe, Message to Dept of Army, subject: "Standardization of PLL," 1 Nov 71.

36. Dept of Army, "Headquarters and Main Support Company, Maintenance Battalion, Infantry Division (Mechanized)," TOE 29-26H, Nov 70.

37. _____, "Headquarters and Main Support Company, Maintenance Battalion, Armored Division," TOE 29-36G, 31 Mar 66. Change 12, 15 Oct 71.

38. ______. DCSLOG, "In Process Review of DSSP, Europe," 22 Feb to 2 Mar 71.

39. US Army Materiel Command, "Minutes, Materiel Readiness Management Project Advisory Group. Study 011.206: A Simulation Approach to Evaluation of Alternative Supply and Maintenance Systems," 12 May 71.

40. Dept of Army, "The Army Maintenance Management System (TAMMS)," TM 38-750, Dec 69.

41. ______. "Logistics Improvements: Direct Exchange," Cir 700-21, May 71.

42. Research Analysis Corporation. "DSS USAREUR Performance Evaluation," unnumbered report, 29 Feb 72.

43. Dept of Army. "Logistics Inventory Management." FM 38-2, Jun 70.

44. Conway J. Christianson, et al, "An Analysis of the Responsiveness of the Seventh Army Repair-Parts Supply System." RAC-TP-158. Research Analysis Corporation, Apr 65.

45. Research Analysis Corporation. "DSS Korea Performance Evaluation." unnumbered report, 29 Feb 72.

46. Leon H. Karadbil, et al. "Logistics of a Field Army Support Command (FASCOM)." RAC-TP-331. Research Analysis Corporation, Dec 68.

47. Stanford Research Institute, "An Integrated Materiel Readiness, Supply and Maintenance Management Information System," Menlo Park, Calif. Sep 68.

48. Dept of Army. "The Army Maintenance Management System (TAMMS) Field Command Procedures." TM 38-750-1. Dec 69.

49. Churchman, C. W., Statistical Manual Methods of Making Experimental Inferences, Pitman-Dunn Laboratory. Frankford Arsenal, Philadelphia. Jun 51.

50. Dept of Army. "Organization and Equipment Tables—Personnel." AR 750-2, change 2, 4 Mar 71.

51. ______. "Heavy Maintenance Company. Maintenance Battalion, Armored Division," TOE 29-36H. 30 Nov 70.

52. ______. "Forward Support Company, Maintenance Battalion. Armored Division." TOE 29-37E. 15 Jul 63. Change 9, 7 May 69.

53. ______. "Forward Support Company. Maintenance Battalion. Armored Division." TOE 29-37G. 31 Mar 66. Change 9. 15 Oct 71.

54. ______. "Forward Support Company, Maintenance Battalion. Armored Division." TOE 29-37H, 30 Nov 70. Change 2. 15 Oct 71.

55. ______. "Transportation Aircraft Maintenance Company. Maintenance Battalion. Armored Division." TOE 55-424G. 31 Mar 66. Change 10. 15 Oct 71.

56. ______. "Transportation Aircraft Maintenance Company. Maintenance Battalion. Armored Division." TOE 55-424H. 30 Nov 70. Change 1. 15 Oct 71.

57. ______, "Light Equipment General Support Maintenance Company," TOE 29-134G, 31 Dec 66. Change 12, 14 Jan 72.

58. ______, "Heavy Equipment General Support Maintenance Company," TOE 29-137G, 28 Feb 67. Change 9, 15 Oct 71.

59. ______, "Labor Service Company," TOE 29-449G, 31 Mar 67.

60. Conway J. Christianson, et al, "An Analysis of the Feasibility of Using Data from the Army Equipment Records System (TAERS) in the Determination of Repair-Parts Requirements for Automotive Equipment," RAC-TP-202, Research Analysis Corporation, Apr 66.

61. Dept of Army, New Cumberland Army Depot, "Army Master Data File Reader Microfilm System: Code Reference Guide," NCAD Pamphlet 18-14, New Cumberland, Pa, 1 May 72.

62. Spurr, Kellogg, and Smith, Business and Economic Statistics, Richard D. Irwin, Inc. Revised Ed. 1961.

63. Mordecai Ezekiel, Methods of Correlation and Regression Analysis, John Wiley and Sons, Inc, New York, Dec 61.

REFERENCE NOT CITED

Craig C. Sherbrooke, "MINE: Multi-Indenture NORS Evaluator," RM-5826-PR, RAND Corporation, Santa Monica, Calif, Dec 68.